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THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES.

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 150 ELEGANT ENGRAVINGS,

BY

MESSRS. LOWRY AND SCOTT.

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BUBROMA, in botany, a genus of the Polyadelphia Dodecandria class and order. Nat. order Columniferæ: Malvaceæ, Jussieu. Essential character: calyx three-leaved; petals five, arched, semibifid; anthers on each filament three; stigma simple; capsule muricate, ending in a five-rayed star, punched with holes, five-celled, valveless, not opening. There is but one species, *viz.* B. guazuma, elm-leaved bubroma or theobroma, or bastard cedar. This tree rises to the height of forty or fifty feet in the West Indies, having a trunk as large as the size of a man's body, covered with a dark brown bark, sending out many branches towards the top, which extend wide every way; leaves oblong, heart-shaped, alternate, nearly four inches long, and two broad near the base, ending in acute points; the branches have a nap scattered over them; they have no buds; the flowers are in corymbs. In Jamaica it is known by the name of bastard cedar, and is peculiar to the low lands there, forming an agreeable shade for the cattle, and supplying them with food in dry weather, when all the herbage is burned up or exhausted. The wood is light, and so easily wrought that it is generally used by coachmakers in all the side pieces; it is also cut into staves for casks.

BUCCANEERS, those who dry and smoke flesh or fish, after the manner of the Americans. This name is particularly given to the French inhabitants of the island of St. Domingo, whose whole employment is to hunt bulls or wild boars in order to sell the hides of the former and the flesh of the latter.

The buccaneers are of two sorts: the buccaneers ox-hunters, or rather hunters of bulls and cows; and the buccaneers boar-hunters, who are simply called hunters; though it seems that such a name be less proper to them than to the former; since the latter smoke and dry the flesh of wild boars, which is properly called buccaneering, whereas the former prepare only the hides, which is done without buccaneering.

Buccaneering is a term taken from Buccan, the place where they smoke their flesh or fish, after the manner of the savages, on a grate or hurdle, made of Brasil wood, placed in the smoke a considerable distance from the fire; this place is a hut of about twenty-five or thirty feet in circumference, all surrounded and covered with palmetto leaves.

BUCCINATOR, in anatomy, a muscle on each side of the face, common to the lips and cheeks. See ANATOMY.

BUCCINUM, in natural history, a genus of the Vermes Testacea. Animal a limax; shell univalve, spiral, gibbous; aperture ovate, terminating in a short canal leaning to the right, with a retuse beak or projection; pillar-lip expanded. There are between two and three hundred species, separated into eight divisions; *viz.* A. inflated, rounded, thin, subdiaphonous, and brittle. B. with a short exserted beak; lip unarmed outwardly. C. lip prickly outwardly on the hind part; in other respects resembling division B. D. pillar-lip dilated and thickened. E. pillar-lip appearing as if worn flat. F. smooth, and not among the former divisions. G. angular, and not included among the former divisions. H. tapering, subulate, smooth.

BUCCO, the *barbet*, in natural history, a genus of birds of the order Picæ. Generic character; bill sharp-edged, compressed on the sides, notched on each side near the apex, bent inwards, with a long slit beneath the eyes; nostrils covered with incumbent feathers; feet formed for climbing. These birds live chiefly in warm climates, and are very stupid; bill strong, straightish, almost covered with bristles; tail-feathers usually ten, weak. There are nineteen species, of which we shall notice only B. jamatia, or spotted-bellied barbet. This bird is found in Brazil and Cayenne, is clumsy in its shape, and pensive and solitary in its manners. It is so lethargic in its disposition, that it will suffer itself to be shot at several times before it attempts to escape. Its food consists of insects, and particularly large beetles, and the feathers of its tail are much worn by friction, so as to indicate the probability of the tail being employed, agreeably to the known habit of woodpeckers, in propping or supporting the body.

BUCEROS, the *hornbill*, in natural history, a genus of birds of the order Picæ. Generic character; their bill is convex, curved, sharp-edged, large, outwardly serrate, with a horny protuberance near the base of the upper mandible; the nostrils are behind the base of the bill; the tongue is sharp-pointed, and short; the feet gressorial. There are sixteen species enumerated by Gmelin, though Latham reckons only four; of these the most curious is, the B. abyssinicus, or Abyssinian hornbill. This is found in the country from which it takes its name, principally among fields of jaff, and nourishes itself by the green beetles which abound in them. Its young are numerous, sometimes amounting even to eighteen. Though capable of flying far, it chiefly runs. It builds its nest in large thick trees, near churches or other elevated buildings: this nest resembles a magpie's, in being covered, but is several times larger than an eagle's; it is seldom much elevated above the ground, but almost always firm on the trunk, and the entrance to it is always from the east. This bird is, in some places, called the bird of destiny.

BUCIDA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Holoracæ. Elæagni, Jussieu. Essential character; calyx five-toothed, superior; corolla none; berry one-seeded. There is but one species; *viz.* B. buceras, olive bark tree, is a tree growing from twenty to thirty feet in height; the branches and twigs are divaricate or flexuose, roundish, smooth, and even flowers, in racemes from the crowded leaves, simple, spreading, many-flowered; calyx hoary without, tomentose within; filaments twice as long as the calyx; anthers roundish, yellow; germ flatted, with ten streaks at the base. It is a native of the West Indies, flowering in spring.

BUCHNERA, in botany, so named in honour of A. C. Buchner, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Juss. Essential character: calyx obscurely, five-toothed; corolla border five-cleft, equal; lobes cordate; capsule two-celled. There are eleven species, of which B. Americana, North American buchnera, has the stem scarcely branching; flowers in a spike remote from each other; two of the stamens in the jaws of the corolla, and two in the middle of the tube. The herb grows black in drying. It is a native of Virginia and Canada. B. cernua, drooping buchnera, is a shrub half a foot in height, branching regularly; a little jointed from the scars left by the leaves, purplish; flowers sessile, erect, with a linear, sharp bracte, shorter than the calyx, and two shorter lateral bristles; calyx tubular, oblong semiquinquefid, equal; corolla white, with a filiform tube, twice as long as the calyx, and bent back; border flat, five-parted; segments subovate; anthers within the jaws, two lower than the other two; stigma inclosed, reflex, thickish. Native of the Cape of Good Hope.

BUCK, in natural history, a male horned beast, whose female is denominated a doe. See CERVUS.

BUCKET, a small portable vessel to hold water, often made of leather for its lightness and easy use in cases of fire. It is also the vessel let down into a well, or the sides of ships, to fetch up water.

BUCKING, the first operation in the whitening of linen-yarn or cloth: it consists in pouring hot water upon a tubful of yarn, intermingled with several strata of fine ashes of the ash tree. See BLEACHING.

BUCKLER, a piece of defensive armour used by the ancients. It was worn on the left arm, and composed of wickers woven together, or wood of the lightest sort, but most commonly of hides, fortified with plates of brass or other metal. The figure was sometimes round, sometimes oval, and sometimes almost square. Most

of the bucklers were curiously adorned with all sorts of figures of birds and beasts, as eagles, lions; nor of these only, but of the gods, of the celestial bodies, and all the works of nature; which custom was derived from the heroic times, and from them communicated to the Grecians, Romans, and Barbarians.

BUCKLERS, *votive.* Those consecrated to the gods, and hung up in their temples, either in commemoration of some hero, or as a thanksgiving for a victory obtained over an enemy; whose bucklers, taken in war, were offered as a trophy.

BUCKRAM, in commerce, a sort of coarse cloth made of hemp, gummed, calendered, and dyed several colours. It is put into those places of the lining of a garment, which one would have stiff and to keep their forms. It is also used in the bodies of women's gowns; and it often serves to make wrappers to cover cloths, serges, and such other merchandises, in order to preserve them and keep them from the dust, and their colours from fading.

BUCOLIC, in ancient poetry, a kind of poem relating to shepherds and country affairs, which, according to the most generally received opinion, took its rise in Sicily. Bucolics, says Vossius, have some conformity with comedy. Like it, they are pictures and imitations of ordinary life; with this difference, however, that comedy represents the manners of the inhabitants of cities; and bucolics, the occupations of country people. Sometimes, continues he, this last poem is in form of a monologue, and sometimes of a dialogue. Sometimes there is action in it, and sometimes only narration; and sometimes it is composed both of action and narration. The hexameter verse is the most proper for bucolics in the Greek and Latin tongues. Moschus, Bion, Theocritus, and Virgil, are the most renowned of the ancient bucolic poets.

BUDDLEA, in botany, so named in honour of Adam Buddle, a genus of the Tetrandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx four-cleft; corol four-cleft; stamens from the divisions; capsules two-furrowed, two-celled, many-seeded. There are eight species, of which B. americana, long spiked buddlea, is a shrub the height of a man; leaves ovate-lanceolate; flowers in long slender spikes, axillary, and terminating; composed of little, opposite, many-flowered, crowded racemes; corolla coriaceous, scarcely longer than the calyx. B. occidentalis; spear-leaved buddlea; this plant is much taller than the first, and divides into a greater number of slender branches, which are covered with a russet hairy bark, with long spear-shaped leaves, ending in sharp points; these grow opposite at every joint; at the end of the branches are produced spikes of white flowers, growing in whorls round the stalks. It grows in sheltered places in the West Indies, being too tender to resist the force of strong winds.

BUDDING, in gardening, is a method of propagation, practised for various sorts of trees, but particularly those of the fruit kinds. It is the only method which can be had recourse to with certainty, for continuing and multiplying the approved varieties of many sorts of fruit and other trees; as although their seeds readily grow, and become trees, not one out of a hundred, so raised, produces any thing like the original; and but very few that are good. But trees or stocks raised in this manner, or being budded with the proper sorts, the buds produce invariably the same kind of tree, fruit, flower, &c. continuing unalterably the same afterwards.

The stocks for this use are commonly raised from seed, as the kernels or stones of these different sorts of fruit, &c. sown in autumn or spring in beds, in the nursery, an inch or two deep, which, when a year or two old, should be transplanted into nursery rows, two feet asunder, and fifteen or eighteen inches distant in the rows, to stand for budding upon, keeping them to one stem, and suffering their tops to run up entire; when of two or three years growth, or about the size of the little finger at bottom, or a little more, they are of due size for budding upon.

Stocks raised from suckers arising from the roots of the trees of these different sorts, layers, and cuttings of them, are also made use of, but they are not so good for the purpose. Budding may likewise be performed occasionally upon trees that already bear fruit, when intended to change the sorts, or have different sorts on the same tree, or to renew any particular branch of a tree; the operation being performed on the young shoots of the year, or of one or two year's growth only. The most proper height to bud stocks varies according to the intention, but from about three or four inches to six feet or more from the ground is practised. To have dwarf trees for walls and espaliers, &c. they must be budded from

within about three to six inches from the bottom, that they may first furnish branches near the ground: for half standards, at the height of three or four feet; and for full standards, at from about five to six or seven feet high; the stocks being trained accordingly. The necessary implements and materials for this purpose, are a small budding knife for preparing the stocks and buds for insertion, having a flat thin haft to open the bark of the stocks in order to admit the buds; and a quantity of new bass strings well moistened to tie them with. In performing the operation of budding, the head of the stock is not to be cut off, as in grafting, but the bud inserted into the side, the head remaining entire till the spring afterwards, and then cut off. A smooth part on the side of the stocks at the proper height, rather on the north side away from the sun, should be chosen; and then with the knife an horizontal cut made across the rind, and from the middle of that cut a slit downwards about two inches in length, in the form of the letter T, being careful lest the stock be wounded. Then having cut off the leaf from the bud, leaving the footstalk remaining, make a cross cut about half an inch below the eye, and with the knife slit off the bud with part of the wood to it, somewhat in the form of an escutcheon, pulling off that part of the wood which was taken with the bud, being careful that the eye of the bud be left with it, as all those buds which lose their eyes in stripping should be thrown away as good for nothing: then having gently raised the bark of the stock where the cross incision was made with the flat haft of the knife clear to the wood, thrust the bud in, placing it smoothly between the rind and the wood of the stock, cutting off any part of the rind belonging to the bud, which may be too long for the slit; and after having exactly fitted the bud to the stock, tie them closely round with bass string, beginning at the under part of the slit and proceed to the top, taking care not to bind round the eye of the bud, which should be left open and at liberty. When the buds have been inserted about three weeks or a month, examine which of them have taken; those which appear shrivelled and black being dead, but such as remain fresh and plump are joined; and at this time loosen the bandage, which, if not done in time, is apt to pinch the stock and greatly injure, if not destroy, the bud. The March following, cut off the stock about three inches above the bud, sloping it that the wet may pass off, and not enter into the stock. To the part of the stock which is left, some fasten the shoot which proceeds from the bud, to prevent the danger of its being blown out, but this must continue no longer than one year; after which it must be cut off close above the bud, that the stock may be covered by it.

BUFF, in commerce, a sort of leather prepared from the skin of the buffalo, which dressed with oil, after the manner of shammy, makes what we call buff-skin. This makes a very considerable article in the French, English, and Dutch commerce at Constantinople, Smyrna, and all along the coast of Africa. The skins of elks, oxen, and other-like animals, when prepared after the same manner as that of the buffalo, are likewise called buffs.

BUFFALO, in zoology, an animal of the ox kind, with very large, crooked, and resupinated horns. See Bos.

BUFFONIA, in botany, so named in honour of the Count de Buffon, a genus of the Tetrandria Digynia class and order. Natural order of Caryophyllei. Essential character: calyx four-leaved; corol four-petalled; capsules one-celled, two-seeded. There is but one species, *viz.* B. tenuifolia; small buffonia, or bastard chickweed, has an annual root, the stem half a foot in height, upright, commonly branched at the base; leaves in pairs at each joint, resembling grass leaves, but when the plant is in flower they are dry and shrivelled; stamens two, sometimes four; filaments very slender, shorter than the corolla, fastened to the receptacle; anthers saffron coloured; the capsule splits at top into two hearts; seeds blackish. It is a native of England, France, Italy, and Spain. It flowers in May and June.

BUFO, *toad.* See Rana.

Bug. See Cimex.

The house bug, or cimex lectuarius, so extremely troublesome about beds, is of a roundish figure, and of a dark cinnamon colour. One of the best methods for extirpating these insects from bedsteads, is by thoroughly washing all the parts where they are likely to lodge with a solution of muriated mercury, or, as it is called in the shops, corrosive sublimate. Great caution should be had in the use of this mixture as it is one of the most deadly poisons known.

BUGINVILLÆA, in botany, a genus of the Octandria Monogynia class and order. Corolla inferior, tubular, four-toothed;

stamina inserted on the receptacle; fruit one-seeded. One species B. spectabilis, found at the Brazils.

BUILDING, a fabric erected by art, either for devotion, for magnificence, or for conveniency.

BUILDING is also used for the art of constructing and raising an edifice; in which sense it comprehends as well the expenses, as the invention and execution of the design. There are three things chiefly to be considered in the art of building, *viz.* convenience, firmness, and delight. To accomplish which ends, Sir H. Wotton considers the subject under these two heads, the situation, and the work. As to the situation, either that of the whole is to be considered, or that of its parts. In the first, regard must be had to the quality, temperature, and salubrity of the air; to the quality of the soil; to the conveniency of water, fuel, carriage, &c. and to the agreeableness of the prospect. As to the situation of the parts, the chief rooms, studies, and libraries, should lie towards the east; those offices which require heat, as kitchens, brew-houses, bake-houses, and distillatories towards the south; those which require a cool fresh air, as cellars, pantries, granaries, to the north; as also galleries for paintings, museums, &c. which require a steady light. The ancient Greeks and Romans generally situated the fronts of their houses towards the south; but the modern Italians vary much from this rule. And indeed, as to this matter, regard must still be had to the country, each being obliged to provide against its own inconvencies.

The situation being fixed on, the next thing to be considered is the work itself, under which come first the principal parts, and next, the accessories or ornaments. To the principals belong the materials, and the form or disposition.

Modern buildings are, in general, much more commodious and beautiful than those of former times. Compactness and uniformity are now so much attended to, that a house built after the new way, will afford, on the same ground, double the conveniences which could be had in an old one.

In this article we shall give an account of the principal parts of a building; beginning with the foundation.

Foundation is the trench or trenches excavated out of the ground in order to rest the edifice firmly on its base. The trenches should be sunk till they come to an uniform firm texture of ground, or to the solid rock; but when there is no prospect of a firm and uniform bed of gravel, clay, or rock, then recourse must be had to an artificial foundation.

If the ground is tolerably firm, lay transverse pieces of oak called sleepers, about two feet distant from each other, firmly on the ground; having their upper surface level with the bottom of the trench, and their length equal to its breadth, or about two feet longer than the width of the intended masonry at the bottom of the wall: over these lay planks in the length of the foundation to the breadth of the masonry, where it is to be in contact with the ground, and pin or spike them down.

But if the ground be very bad, provide piles of wood of such length that they may be able to reach the sound ground, and of such thickness as to be about a twelfth part of their length, and drive these either close to each other, or with interstices such as the soil may require, and fix planks to their heads or upper ends.

If the ground be generally sound, turn arches over the loose places. When narrow piers are to stand upon the foundation, inverted arches might be turned below the apertures, in order to present a greater surface of resistance to the ground. When the outer walls of a building are piled, the inner ones must be so likewise, that the whole may stand uniformly firm, without possibility of one wall sinking from another.

If narrow piers are to support a great structure, planks should be placed below, in order to prevent the piers from penetrating the ground. If a building is founded upon an inclined plane, the trenches should be made like steps, having their upper surfaces level, and the risings perpendicular.

Forced earth is unfit for a foundation for a considerable time.

Foundation is also the substructure, or bottom of a wall, consisting of one or more regular steps on each side of the wall below the level of the underside of the floor of the lowest story of a house, in order to prevent it from sinking into the ground, by opposing a greater surface of resistance to it, and for preventing the wall from being overturned by a tempest or storm: each course of steps is called a footing.

The breadth of the substructure should be proportioned to the weight of the superstructure, and to the softness of the ground on which it rests; if the texture of the ground is supposed to be constant, and the materials of the same specific gravity, the

breadth of the foundation will be as the area of the vertical section passing through the line on which the breadth is measured: thus for example, suppose a wall 40 feet high, 2 feet thick, to have a sufficient foundation at 3 feet in breadth, what should be the breadth of a foundation of a wall 60 feet high, $2\frac{1}{2}$ feet thick: by proportion it will be $40 \times 2 : 3 :: 60 \times 2\frac{1}{2}$: the ans. $= 5\frac{5}{8}$ feet. This calculation will give the breadth of the foundation of the required wall, equal to the breadth of the insisting wall itself; when the height of the required wall is equal to the ratio, which is the first term $40 \times 2 = 80$, divided by the second term 3, that is $\frac{80}{3} = 26\frac{2}{3}$, Thus a wall of $26\frac{2}{3}$ feet, would have the breadth of its foundation, equal to its thickness above the foundation, and less than $26\frac{2}{3}$ feet, would have a thinner foundation, than even the superstructure. But though the calculation in this case gives the foundation less breadth than the thickness of its superstructure, it must be considered that it only calculates the true breadth of surface that should be opposed to the ground, in order to prevent the wall from penetration by its weight: though the rule gives all the breadth that is necessary, on account of the weight of the insisting wall, yet the breadth of the substructure should always be greater than that of the superstructure; as it will stand more firmly on its base when affected by lateral pressure, and be less liable to rock by the blowing of heavy winds. The least breadth that is commonly given to the substructure of stone walls is one foot thicker than the superstructure. In damp foundations the superstructure should always be separated from the substructure by lead, tarred paper, or other means.

Stone Arch. Stone arch is a number of stones so arranged that, in consequence of their pressure upon one another and upon their supports, they may be suspended over a hollow space; every interior stone being such that if a plummet be depended by a line from any point in that stone, the line will fall within the hollow space.

Stone arches are generally hollow below, and concave towards that hollow. The interior stones ought to be truncated wedges, and their faces, which form the intrados, of less dimensions than the upper opposite surfaces which form the extrados; so that when any stone endeavours to descend through the aperture which surrounds it, it will be prevented by the dimensions of the lower part of the aperture being less than those of the top of the stone which has to fall through it.

Wedge-like stones forming an arch are arch stones.

The joints between the arch stones are called sommerings.

The support or supports of an arch are called the reins of that arch.

When the support or supports of an arch are stone walls, the upper course or courses on which the beds of the extreme arch stones rest, are called the imposts.

Spring course or chaptrels of the arch, and beds themselves, are called the butments or abutments, or spring beds, or skew backs of the arch.

When an arch is either recessed in any piece of masonry, or forms the head of an aperture through that piece of masonry, the arch stones which are common to the intrados and to the face of the masonry; are called voussoirs, and the middle voussoir is called the key stone.

Stone arches are used for a variety of purposes, in supporting different parts of a building, over apertures when the apertures are too wide for lintelling, and over a wooden or stone lintels, to assist in supporting the superincumbent building.

Arches are also used to prop the sides of a building, and in soft foundations inverted arches are used, between narrow piers, to prevent the pier from penetrating, by opposing a greater surface of resistance to the ground.

Floors and roofs are frequently supported with arches, in order to render the building more secure from fire.

Arches employed for several of these purposes have been denominated as follows; those over wooden lintels have been called occult discharging arches, or arches of discharge; those used to prop the sides of a building are called arch boutants, or flying buttresses; and those over apertures, the intrados of which are horizontal planes, have been absurdly called straight arches; it is only for the property of its radiating joints this last is called an arch.

Because the courses in every kind of masonry ought to be horizontal, or the nearest position to it that the nature of the arch will admit of; in stone arching, it follows that when the intrados is a rotative figure with a vertical axis, the coursing joints will be conic surfaces, and their intersections upon the intrados horizontal circles, and the transverse joints will be planes sending to the axis: when the axis is horizon-

tal, the coursing joints will be planes tending to the axis, and the transverse joints will be either vertical circular rings, or conic surfaces, having the same common axis with the intrados.

Stone Walls. Stone walls are those built of stone, with or without cement in the joints; the bedding joints have most commonly a horizontal position in the face of the work; and this ought always to be the case when the top of a wall terminates in a horizontal plane or line. In bridge building, and in the masonry of fence walls upon inclined surfaces, the bedding joints on the face sometimes follow the direction of the top or terminating surface.

The footings of stone walls ought to be constructed of large stones, which if not naturally near the square from the quarry, should be reduced by hammer dressing to that form, and to an equal thickness in the same course; for, if the beds of the stones of the foundation are suffered to taper, the superstructure will be apt to give way, by resting upon mere angles or points; or upon inclined surfaces the footings ought to be well bedded upon each other with mortar, and all the upright joints of an upper footing should break joint; that is, they should fall upon the solid of the stones below, and not upon the joint.

The following are methods practised in laying the footings of a stone foundation: when the walls are thin and stones can be got conveniently, that their length may reach across each footing from one side of the wall to the other, the setting of each course with whole stones in the thickness of the wall should be preferred. But when the walls are thicker, and bond stones in part can only be conveniently procured, then every other succeeding stone in the course may be a whole stone in the thickness of the wall; and every other interval may consist of two stones in the breadth of the footing; this is placing the header and stretcher alternately, like Flemish bond in nine-inch brick work. But when bond stones cannot be had conveniently, every alternate stone should be in length two-thirds of the breadth of the footing upon the same side of the wall; then upon the other side of the wall a stone of one-third of the breadth of the footing should be placed, opposite to one of two-thirds; and one of two-thirds opposite to one of one-third; so that the stones may be placed in the same manner as those of the other side.

In broad foundations where stones cannot be procured for a length equal to two-thirds of the foundation, then build them alternately, with the joints on the upper bed of each footing, so that the joint of every two stones may fall as nearly as possible in the middle of the length of the one, or each adjoining stone; observing to dispose the stones alike on each side of every footing. A wall, the superstructure of which is built of unhewn stone laid in mortar, is called a ruble wall. They are of two kinds, coursed and uncoursed. The most common kind of ruble is the uncoursed, of which the greater part of the stones is crude, as they came out of the quarry, and the rest hammer dressed. This kind of walling is very inconvenient for the building of bond timbers; but if they are to be preferred to plugging the backing must be levelled in every height in which the bond timbers are disposed. The best kind of ruble is the coursed; the courses are all of accidental thicknesses, adjusted by a sizing rule, as the slating of a roof; the stones are either hammer dressed or axed. This kind of work is favourable for the disposition of bond timbers, but as all buildings, constructed either in whole or in part of timber, are liable to be burnt, strong well built walls should never be bound with timber, but should rather be plugged, for if such accident take place the walls will be less liable to warp.

Walls faced with squared stones, hewn or rubbed, and backed with ruble stone or brick, are called ashler. The medium size of each ashler measures horizontally in the face of the wall about 28 or 30 inches; in the altitude one foot, and in the thickness 8 or 9 inches. The best figures of stones for an ashler facing are formed like truncated wedges; that is to say, they are thinner at one end than at the other in the thickness of the wall, so that when the stones of one course, or a part of a course, are shaped in this manner, and alike situated to each other, the back of the course will form an indention like the teeth of a joiner's saw, but more shallow in proportion to the length of a tooth; the next course has its indentations formed the same way, and the stones so selected, that the upright joints break upon the solid of the stones below.

By these means, the facing and backing are toothed together, and unquestionably stronger than if the back of each ashler had been parallel to the front surface of the wall; as the stones are mostly raised in quarries of various thicknesses, in an ashler facing, it would greatly contribute to the strength of the work to select the stones in each course, so that every alternate ashler

may have broader beds than those of every ashler placed in each alternate interval. In every course of ashler facing bond stones should be introduced, and their number should be proportioned to the length of the course. This should be strictly attended to in long ranges of stones, both in walls without apertures and in the courses that form wide piers; when they are wide, every bond stone of one course should fall in the middle of every two bond stones in the course below. In every pier where the jambs are coursed with the ashler, and also in every pier where the jambs are one entire height, every alternate stone next to the aperture in the former case, and every alternate stone next to the jambs in the latter case, should bond through the wall, and also every other stone should be placed lengthwise, in each return of an angle, not less than the average length of an ashler. Bond stones should have no taper in their beds; the end of every bond stone, as well as the end of every return stone, should never be less than a foot. There should be no such thing as a closer permitted, unless it bond through the wall. All the uprights, or joints, should be square, or at right angles to the front of the wall, and may recede about $\frac{3}{4}$ths of an inch from the face, from thence gradually widen to the back, and thereby make hollow, wedge-formed figures, which will give sufficient cavities for the reception of packing and mortar.

Both the upper and lower beds of every stone should be quite level, and not form acute angles, as is often the case; the joints from the face to about $\frac{3}{4}$ths of an inch within the wall should be either cemented with fine mortar, or with a mixture of oil, putty, and white lead: the former is the practice both in London and Edinburgh, and the latter in Glasgow. The putty cement will stand longer than most stones, and will be prominent when the face of the stones has been corroded with age. The whole of the ashler, except that mentioned of the joints toward the face of the wall, the ruble work, and the core, should be set and laid in the best mortar, and every stone laid on its natural bed.

All wall-plates should be placed upon a number of bond stones, and particularly those of the roof; by which means they may either be joggled upon the bonds, or fastened to them by iron and lead. In building walls or insulated pillars of very short horizontal dimensions, not exceeding a length of stones that can be easily procured, every stone should be quite level on the bed, without any degree of concavity, and should be one entire piece between every two horizontal joints. This should be particularly attended to on piers, where the insisting weight is great, otherwise the stones will be in danger of splintering and crushing to pieces, and perhaps occasion a total demolition of the fabric. Vitruvius has left us an account of the manner of the construction of the walls of the ancients, which were as follows: the reticulated is that wherein the joints run in parallel lines, making angles of 45° each with the horizon in contrary ways, and consequently the faces of the stones form squares, of which one diagonal is horizontal, and the other vertical. This kind of wall was much used by the Romans in his time. The incertain wall was formed of stones of which the one direction of the joints was horizontal, and the other vertical; but the vertical joints of the alternate courses were not always arranged in the same straight line: all that they regarded was to make them break-joint. This manner of walling was used by the Romans in times antecedent to the time of Vitruvius. Vitruvius directs, that in both the reticulated and incertain walls, instead of filling up the spaces between the sides with ruble promiscuously, they should be strengthened with abutments of hewn stone or bricks, or common flints, built in walls two feet high, and bound to the front with cramps of iron. The emplection consisted of two sides or shells of squared stone, with alternate joints, and a ruble core in the middle.

The walls of the Greeks were of three kinds, named isodomum, pseudosodomum, and emplection. The isodomum had the courses all of an equal thickness; but the pseudosodomum had them unequally thick: in both these walls, wherever the squared work was discontinued, the interval, or core, was filled up with common hard stones, laid in the manner of brick, with alternate joints. The emplection was constructed wholly of squared stones; in these bond stones were placed at regular intervals, and the stones in the intermediate distance were laid with alternate joints in the same manner as those of the face: so that this manner of Greek walling must have been much stronger than the emplection of the Roman villagers. This is a most strong and durable manner of walling, and in modern times it may be practised with the utmost success; but in the common run of buildings it would be too expensive.

Stone Columns. Stone columns should be executed with as few joints as possible; if they can be procured in one piece, they will have a much grander effect: there should be no such things as vertical joints; for they not only destroy the beauty of the column, but are inconsistent with the laws of strength. Before the number of pieces can be fixed, two important circumstances must be taken into consideration: first, to find out those quarries which will produce durable stones, of the size and colour wanted, and the nearer to the place of erection the better; next, to inquire concerning the price of the carriage; if these come within the maximum limit of what the proprietor would chuse to fix, then the number of pieces is determined; but, if not, this number must be increased, in order to make it equal to, or less than, the proposed sum, observing to choose the nearest odd number. The circumstances being thus accommodated to each other, and the stones laid down at the place intended for building, draw a section of the column through its axis, to the full size; divide the height of this section, by lines parallel to the base, into heights equal in number to that of the stones; by these means, the diameters of each end of every stone in the altitude will be determined. The upper and lower bodies of each stone are first to be wrought exactly to parallel planes, and as one great beauty of columns is to make them appear at a small distance, as if they were in one entire piece, they should be rubbed at first with a large coarse stone, in order to prevent the surface from being excavated, and then with a fine stone of the same size as the coarse one; with the utmost care observing to try the straight edge, or rule, as the rubbing goes on; in this the edge of the rule should always coincide with the surface, otherwise the two superfices which are to form the joint can never coincide. The two beds of a stone being thus formed, find the centre, and describe the circle at one end, divide the circumference into a convenient number of equal parts; (it is usual to divide it into six or eight); draw lines from each point to the centre; find the centre of the circle on the other bed, so that the two centres may be in the straight line forming the axis of the column; that is, when the straight line joining their centres is perpendicular to each bed; through the centre of this last circle draw a straight line, parallel to any one of the lines drawn through the centre and circumference of the former; also from the point in the circumference of the last drawn circle, where the line drawn through the centre cuts this circle, divide the circumference into the same number of equal parts as that of the circle formerly drawn; then draw lines from the centre to each of the points so divided, and these lines will be respectively parallel to those of the former circle; the extremities of each pair of parallel lines, in each circumference, will regulate the chisel draught, which is to be wrought along the surface of the column. The corresponding draught being made from each pair of parallels, the spaces between will be more easily wrought down; then, if the number of pieces which compose the column exceed seven or nine, a straight edge may be applied, the side of which always being in a plane passing through the axis; but if fewer pieces are used, make a diminishing rule, that is, one to the curve line of the column: on the side of the diminishing rule draw a straight line parallel to the axis; this rule will serve to plumb the stones in setting them; and to work the convex surface of each stone; prepare another rule, equal in length to that of a stone, having its edge curved the same as the diminishing rule.

The cement used in setting each column stone is either oil-putty, or white lead, or white lead mixed with chalk-putty, or fine mortar, or milled lead rolled very thin. If the column be large, and rolled lead be used, it needs only to form a ring half an inch distant from the edge of the joint, and let the joint at the edge be filled with oil-putty.

Stone Stairs. When stairs are supported by a wall at both ends, nothing difficult can occur in the construction; in this the inner ends of the steps may either terminate into a solid newal, or be tailed into a wall surrounding an open newal. Where elegance is not required, and where the newal does not exceed two feet six inches, the ends of the steps may be conveniently supported by a solid pillar; but when the newal is thicker, a thin wall surrounding the newal would be cheaper. In the stairs of a sunk story, where there is a geometrical stair above, the steps next to the newal are generally supported upon a dwarf wall. Geometrical stairs have the outer end fixed in the wall, and one of the edges of every step supported by the edge of the step below, and constructed with sally-formed joints; so that they cannot descend in the inclined direction of

the stair, nor yet in a vertical direction; the upper sally of every step forms an interior obtuse angle, called a back rebate, and the lower, of course, an exterior one; and the joint formed of these sallies is called a joggle. The upper part of the joint may be level from the face of the risers, to about one inch within the joint.

This is the plane of the tread of each step, continued one inch within the surface of each riser; the lower part of the joint is a narrow surface, perpendicular to the rake of the stair, at the end next to the newal. In stairs constructed of most kinds of stone, the thickness of every step, at the thinnest place of the end next to the newal, has no occasion to exceed two inches, for steps of four feet in length, that is, by measuring from the interior angle of every step perpendicular to the rake.

The thickness of steps at the interior angle should be proportioned to the length of the step; but allowing that the thickness of the steps at each interior angle is sufficient at two inches, then will the thickness of the steps at the interior angles be half the number of inches that the length of the steps has in feet: thus, a step five feet long would be two inches and a half at that place.

The stone platform of geometrical stairs, *viz.* the landing half spaces, and quarter spaces, are constructed of one, two, or several stones, according to the difficulty of procuring them. When the platform consists of two or more stones, the first platform stone is laid upon the last step that is set, and the one end wedged in the wall: the next platform stone is joggled, or rebated, into the one next set, and the end again fixed in the wall, as that and the preceding steps are, and every stone in succession, till the platform is completed. If there is occasion for another flight of steps, the last platform becomes a spring stone for the next step; the joint is to be joggled, as well as all the succeeding steps, in the same manner as the first flight. Geometrical stairs, executed in stone, depend on the following principle: that every body must at least be supported by three points, placed out of a straight line, and, consequently, if two edges of a body in different directions be secured to another, the two bodies will be immoveable in respect of each other. This last is the case in a geometrical stair: one end of a stair stone is always tailed into the wall, and one edge either rests on the ground itself, or on the edge of the preceding stair stone, whether the stair stone be a plat or step. The stones forming a platform are generally of the same thickness as those forming the steps.

Roofs. Roof is that part of a building raised upon the walls, and extending over all the parts of the interior, which consists not only of the covering or exterior part, but of all the necessary supports of that part, for protecting its contents from inclement seasons. There are many forms of roofs, the most simple of which is that which has only one plane, and is called a shed roof; but the form which has always been, and still continues to be in most general use, wherever the nature of climate requires it to be raised, is that the vertical section of which consists of two sloping sides, is consequently triangular, and called a span roof.

Here it will be proper to say something of the changes of inclination or pitch which have prevailed in this simple form, among different nations, from time to time, arising as well from the nature of the climate as the caprice of the people, and as transmitted down to the present age. The ancient Egyptians, Babylonians, and Persians, as well as other eastern nations; and also the present inhabitants of those climates, where rain seldom appears, make their roofs quite flat. The ancient Greeks, perceiving the inconvenience of this, raised them in the middle with a gentle inclination towards the sides; the height from the middle to the level of the walls not exceeding $\frac{1}{9}$th or $\frac{1}{8}$th part of the span; as may be seen by many ancient temples still remaining in that country. The Romans made the height from $\frac{1}{5}$th to $\frac{2}{9}$th parts of the span. After the decline of the Roman empire, high pitched roofs began to be in general request all over Europe, and the vertical section of that which most generally prevailed, seems to have been an equilateral triangle, which was considered as the standard. In Germany this has been remarkable, from very remote antiquity, as appears from Vitruvius: the equilateral pitch, and that of a higher one, appears to have continued as long as pointed architecture prevailed.

When Grecian and Roman architecture was first introduced into this country from Italy, roofs began to be made lower, and the rafters were $\frac{3}{4}$ths of the breadth of the building: this was called true pitch, and subsequently the square seems to have been considered as the true pitch. In these

several gradations of changes, the material for the covering has been supposed to be impervious stone or slates, and the roofs themselves to be those which cover ordinary dwellings; for, after the Italian architecture began to prevail in the last century, platform roofs, and those of a pediment pitch, were introduced in many sumptuous mansions and public edifices; but the material employed for covering was lead. At the present day, when good slates are to be had in abundance, we can execute roofs to the Grecian declivity; but with regard to the general practice, the pitch of the roof depends on the style of architecture introduced in the buildings; the proportion of the pitch in ordinary dwellings, is between $\frac{1}{3}$d and $\frac{1}{4}$th part of the span; mansions and public buildings are executed in every style that has prevailed in different times, and among different people; and the proportion of the roof, as well as other parts, are rigidly adhered to: this consequently produces a great diversity in the heights.

There are some advantages in high pitched roofs; they discharge the rain with greater rapidity; snow continues to lie a much shorter time on their surface, and they are less liable to be stripped by heavy winds.

Low roofs require large slates, and the utmost care in the execution; but they have, however, this advantage, that they are much cheaper, since they require shorter timbers, and consequently much smaller scantling; besides, they have less pressure on the walls. The roof is one of the principal ties to a building, when executed with judgment, as it binds the exterior walls together. There are a variety of forms in the vertical section of roofs, besides the simple and customary one above mentioned. The figure of the roof depends on two or more vertical and horizontal sections. A span, or pent roof, is that which stands upon walls of a quadrangular plan, and of which the transverse vertical section is every where a triangle throughout its length; and slopes from two opposite sides. A hipt, or Italian roof, is that the sides of which incline alike to the horizon, and terminates either in a point, line, or raised platform. Vitruvius calls a hipt roof, which rises from a rectangular plan, a testudinated roof, or simply a testudo. When the plan of a roof is a parallelogram, and when the vertical section across the two opposite walls which have not a greater span than that across the other two walls, consists of four sloping sides on the outside; each two forming an exterior angle: the roof is called a curb or mansard roof, whether there are gables on the other two sides of the building, or the different sides of the roof, equally inclined, all around upon each respective wall.

Figures of roofs which rise from square, rectangular, and polygonal plans, forming only exterior angles on the outside, and which terminate in a point over the centre of the plan, are denominated from the base on which they rise, and from a vertical section passing through the apex, perpendicular to any one of the sides of the base and to the horizon; that is, a roof standing upon a square pentagonal or octagonal plan, having a triangular vertical section, is called a square pentagonal or octagonal pyramidal roof; when such a roof is said to be polygonal, the epithet only applies to the figure of the base. An octangular roof is one whose base is an octagon, whatever be the form of the vertical section. All roofs, the horizontal sections of which are similar figures, either polygons as above described, or circles or ellipses, and the vertical sections of which are segments of convex curves, such as of circles, ellipses, parabolas, &c. are called domes; hence a square dome is one that rises from a square plan; an octangular dome, from an octangular plan; a circular dome, from a circular plan; and an elliptic dome, from an elliptical plan. Domes upon circular plans are called cupolas. A circular or elliptical roof, the vertical section of which consists of two similar and equal concave curves meeting in the apex, is called a trumpet-mouthed roof. When the roof is circular or elliptical, and the vertical section an isosceles triangle, the apex of which is that of the roof, the roof is simply called a conical or conoidal roof. When the vertical section of a circular dome is a parabola, hyperbola, or ellipsis, the dome is then called a paraboloidal dome, a hyperboloidal dome, or ellipsoidal dome; these epithets comprehending both the base of the figure and vertical section. All figures of roofs, which insist on the foregoing bases, whatever be the form of their vertical sections, are called by the general name of pavilion roofs, as they only cover one simple building. From the intersections of two or more simple roofs of the same or of different kinds, a multitude of complex figures will be formed; the plans of some of these are denominated by letters of the alphabet, as an ell roof is one which rests upon a plan in the form of the

letter L; a tee roof upon a plan in the form of the letter T; and an aitch roof upon a plan formed like the letter H; but when two common roofs, having their ridges parallel to each other, and a side of the one either joins one of the other, or these two sides intersect each other, and thereby leave a gutter above the roof; then the roof which is thus compounded of the two simple roofs, is called an em roof, as the verticle section is in the form of the letter M, or rather an inverted W as M: this is an instance where the roof is denominated by the vertical section, and not by the plan. All roofs whatever are said to be truncated, whether they terminate in a plane or raised platform, or have a void at the top, bounded by a level curb.

When the side of a roof is a plane surface, except at the eaves, at which place it is concave, the roof is said to have a bell cast at that place.

The general names of the timbers are straining pieces, tie pieces, and bearers: under straining pieces are included principal rafters, camber beams, hip and valley rafters, collar beams, or straining beams, straining sills, struts, auxiliary rafters, or principal braces and studs.

Under tie pieces are included, tie beams, diagonal ties, and truss posts; and under bearers are included, plates, purlins, common rafters, small rafters, ridge pieces, boarding and dragon beams.

The sloping sides of roofs are of two kinds, single and double, or plain, and carcase: single roofs are those which have one row of rafters upon the same side; double or carcase roofs are those which have two tie of rafters; the lower tie supporting the upper by the intervention of transverse pieces called purlins.

Stone Bridges. A stone bridge is a thick wall built across a hollow, with one, two, three, or a series of apertures, formed into arcades, which either serve to lighten the masonry, or to give passage to a stream of water, or both.

When a stone bridge is resolved upon, the first consideration is its place: in this several particulars should be taken into consideration, and the advantages compared to the disadvantages. As the height of the bridge depends on the banks of the river, the expense will be increased according to their height, therefore a convenient situation should be chosen, where the banks will be adequate in height to that necessary for the bridge, though the expense will be increased by the length of the bridge. In most cases, where the river runs in the valley, a wide part of the stream must be preferred to a narrow part, as the water at this narrower part has not only a greater degree of velocity of itself, but the velocity would also be increased by the piers of the bridge; in times of heavy floods it would be liable to be thrown down, and in a navigable river the navigations would be impeded. As the expense depends on the bed of the river, it must also be taken into the account.

These being settled, the form and heights of the arches come next under consideration; the height of the arches, which determine that of the bridge, depends on the rise of the water in time of floods; and whether there is to be a navigation, and what kind of vessels there are to pass.

Stone bridges ought to be constructed with as few arches as possible, which will not only give greater beauty, but will require fewer foundations, piers, and centerings, and also easier passage for craft. The piers ought to be so proportioned as to enable them to withstand the thrust of the adjacent arches, though the rest were thrown down. The number of arches ought to be odd, in order that one may stand in the middle, where the stream has its greatest velocity.

When the passage-way along the top of the bridge is a convex curve, the arches should diminish from the middle towards each extreme, so as to be similar to the middle one, this will allow a more free passage to the water, the velocity being greatest in the middle. With respect to the choice of arches, the elliptical, cycloidal, and equilibrated arches, are not only convenient, in allowing more room for the passage of ships at the hanches; but they are also more strong, and require fewer materials than most other curves of the same dimensions.

When the extrados is convex, and the height of the arch small in proportion to the span, a segment of a circle may be used with success: in this case the arch should not exceed 60 degrees.

These particulars being fixed, the practice is as follows:—When the foundation of a stone bridge is to be laid in a river which is not very deep, a single or double inclosure of wood is formed, and the intervening space is rammed well with clay or chalk, to prevent the water from coming in. These inclosures are either made with piles driven closely together, and dovetailed at their

joinings, or by piles driven at certain distances from one another, and grooved on the sides opposite each other, and the intervals are shut with boards let in between the groves. This kind of fence against the water is called a batterdeaux, or coffer-dam. The batterdeaux, or coffer-dam, requires a good foundation of solid earth or clay. If the bed of the river be of a loose consistence, the water will ooze through it in too great abundance. The sides of the inclosure must be made very strong, and well braced within, to prevent the ambient water from forcing its way into the batterdeaux.

Where the water is deep, but having a sound bottom, a strong chest, called a caisson, must be formed, so that the sides may easily be disengaged from the bottom of the river, being bevelled, where the pier is to be built, and the caisson properly placed over it, and kept in this situation by ropes: begin to build, and as the work advances it will sink gradually, and at the same time keep continually bracing the sides with timber, to prevent the ambient water from crushing it together, and thereby not only spoiling the work, but drowning the workmen. When the pier is of such height as to be deeper than the water, the sides may be disengaged, and the bottom of the caisson will remain under the pier, as a footing on which it is to rest: for this purpose the bottom of the caisson should be made very strong. Where the foundation is not firm, recourse must be had to piling, as in other such foundations.

With regard to the superstructure of a stone bridge, the arch stones sometimes terminate in a curve parallel to the intrados, and sometimes the joints of the arch stones are continued through the spandrils, observing to break joint sideways; at other times the upper ends of the arch stones terminate so as to fit the beds and upright joints of every course of stone. The joints of the arch stones are sometimes joggled with plugs, in order to prevent them from passing each other. The piers are generally solid pieces of masonry from the foundation till they come to the spring, or above the spring of the arch; thence arches, or complete cylindrical vaults, are sometimes thrown, in order to lighten the bridge, and brace every two adjacent arches between which they are placed. When the abutments are deep, and extend considerably along the road-way at each end, walls on each side of the road-way should be built, similar to those used in aquatic piers, and either strengthened with counterforts, or vaulted under and across the road-way. When there is a heavy pressure of earth between the sides of the abutments, these sides should be both concave in any verticle and also in any horizontal sections.

In stone bridges, when the extrados is a curve, and when the work is coursed, the intersection of the bedding joint of every two courses on the face of the masonry ought to be parallel to the intersection of the extrados with this face; as this position of the joints is not only more beautiful, but is also more agreeable to the laws of strength than those bedding joints which have their intersections in horizontal planes.

BULB, or BULBOUS *root*, in the anatomy of plants, expresses a root of a round or roundish figure, and usually furnished with fibres at its base. See BOTANY.

BULBOCODIUM, in botany, a genus of the Hexandria Monogynia class and order. Liliaceous plants. Order Spathaceæ: Narcissi, Jussieu. Essential character: corolla funnel-form, hexapetalous, with a narrow claw bearing the stamens; capsule superior. There is but one species, *viz.* B. vernum, spring flowering bulbocodium, resembles the common colchicum in shape, though much smaller; it is covered with a dark brown skin. About the middle of February, according to the season, the flowers spring up inclosed within three brownish green leaves, opening themselves as soon almost as they are out of the ground, and shew their buds for flowers within them very white, before they open far; though sometimes purplish at first appearing. There is frequently but one flower, and never more than two; they are smaller than those of colchicum. After the flowers are past the leaves grow to the length of a finger, and in the middle of them rises up the seed vessel, which is smaller, shorter, and harder than that of colchicum, and contains many small brown seeds. It is a native of Spain and of Russia in mountainous situations.

BULIMY, a disease in which the patient is affected with an insatiable and perpetual desire of eating; and, unless he is indulged he often falls into fainting fits. It is also called *fames canina*, canine appetite.

In the third volume of the "Memoirs of the Medical Society of London," is inserted the history of a case of bulimy, accompanied with vomiting, wherein 379*lbs.* of meat and drink were swallowed in the space of six days; yet the patient lost flesh rapidly. A cure was effected by giving food boiled

down to a jelly, frequently, and in small quantities. In this form the food was retained, and the body being duly supplied with nourishment, the stomach and rest of the system recovered their proper tone and energy. But the most extraordinary instance of buliny which perhaps ever occurred, is that recorded in the third volume of the "Medical and Physical Journal," communicated by Dr. Johnson, commissioner of sick and wounded seamen, to Dr. Blane, formerly physician to the navy. The subject was a Polish soldier, named Charles Domery, in the service of the French, on board of the Hoche frigate, which was captured by the squadron under the command of Sir John Borlase Warren, off Ireland, in 1799. He was 21 years of age, and stated that his father and brothers had been remarkable for their voracious appetites. He began when he was 13 years of age. He would devour raw and even live cats, rats, and dogs, besides bullock's liver, tallow-candles, and the entrails of animals. One day (*viz.* September 7th, 1799), an experiment was made of how much this man could eat in one day. This experiment was made in the presence of the before-mentioned Dr. Johnson, Admiral Child, and Mr. Foster, agent for prisoners at Liverpool, and several other gentlemen. He had breakfasted at 4 o'clock in the morning on 4*lbs.* of raw cow's udder; at half past nine o'clock there were set before him 5*lbs.* of raw beef and 12 tallow-candles of 1*lb.* weight, together with 1 bottle of porter; these he finished by half past ten o'clock; at one o'clock there were put before him 5*lbs.* more of beef, 1*lb.* of candles, and 3 bottles of porter: he was then locked up in the room and sentries were placed at the windows to prevent his throwing away any of his provisions. At two o'clock he had nearly finished the whole of the candles and great part of the beef; but without having had any evacuations by vomiting, stool, or urine. His skin was cool, pulse regular, and spirits good. At a quarter past six he had devoured the whole, and declared he could have eat more; but the prisoners on the outside having told him that experiments were making upon him he began to be alarmed.

BULK *heads* are partitions made athwart the ship with boards, by which one part is divided from the other; as the great cabbin, gun-room, bread-room, and several other divisions. The bulk head afore is the partition between the forecastle and gratings in the head.

BULK, *breaking*. See BREAKING.

BULL. See BOS.

BULL *finch*. See LOXIA.

BULL, among ecclesiastics, a written letter dispatched by order of the Pope, from the Roman chancery, and sealed with lead, being written on parchment, by which it is partly distinguished from a brief. See BRIEF.

BULL, *golden*, an edict or imperial constitution, made by the Emperor Charles IV. reputed to be the magna charta, or the fundamental law of the German empire.

It is called golden because it has a golden seal in the form of a pope's bull, tied with yellow and red cords of silk: upon one side is the Emperor represented sitting on his throne, and on the other the capital of Rome. It is also called Caroline on Charles IV's account. Till the publication of the golden bull, the form and ceremony of the election of an emperor were dubious and undetermined, and the number of the electors not fixed.

This solemn edict regulated the functions, rights, privileges, and pre-eminences of the electors. The original, which is in Latin, on vellum, is preserved at Frankfort; this ordinance, containing thirty articles or chapters, was approved of by all the princes of the empire, and remains still in force.

BULLA, in natural history, a genus of insects of the Vermes Testacea. Animal a limax; shell univalve, convolute, unarmed, with teeth; aperture a little straightened, oblong, longitudinal, very entire at the base; pillar oblique, smooth. There are nearly sixty species. B. lignaria is found on European coasts, and is about three inches long. The shell is thin, of a dirty colour, but within it is white. The inhabitants of this species, and, according to Gmelin, those of most of the genus, are furnished with an organ resembling the gizzard of a fowl, and which they appear to use for the purpose of masticating their food.

BULLET, an iron or leaden ball, or shot, wherewith fire-arms are loaded. Bullets are of various kinds; *viz.* red-hot bullets, made hot in a forge, intended to set fire to places where combustible matters are found. Hollow bullets, or shells made cylindrical, with an aperture and fusee at one end, which giving fire to the inside when in the ground, it bursts, and has the same effect with a mine. Chain-bullets, which consist of two balls, joined by a chain, three or four feet apart. Branch-bullets, two balls joined by a bar of iron

five or six inches a-part. Two-headed bullets, called also angles, two halves of a bullet, joined by a bar or chain.

The diameter of a leaden bullet, weighing one pound, is 1.69 inches, according to Sir Jonas Moore; or by a table in Muller's "Treatise of Artillery," 1.672 inches; and the diameter of any other bullet is found by dividing 1.69 inches by the cube root of the number, which expresses how many of them make a pound; or by subtracting continually the third part of the logarithm of the number of bullets in the pound, from the logarithm .2278867 of 1.69, and the difference will be the logarithm of the diameter required. Thus the diameter of a bullet, of which 12 make a pound, will be found by subtracting .3597270, a third part of 1.0791812 the logarithm of 12, from the given logarithm .2278867; or because this logarithm is less than the former, an unit must be added, so as to have 1.2278867; and then the difference .8681597 will be the logarithm of the diameter sought, which is .738 inches, observing that the number found will be always a decimal, because the number subtracted is greater than the other. We may also deduce the diameter of any bullet from its given weight, provided that the specific gravity of lead is known; for, since a cubic foot of lead weighs 11325 ounces, and 678 is to 355 as the cube of a foot or 12 inches, *i. e.* 1728, to the content of a sphere, which is therefore 5929.7 ounces; and since spheres are as the cubes of their diameters, the weight 5929.7 is to 16 ounces, or one pound, as the cube 1728 is to the cube of the diameter of a sphere, which weighs sixteen ounces or one pound; which cube is 4.66263, and its root is 1.6706, the diameter sought.

By the rule above laid down is calculated the following table, shewing the diameters of leaden bullets, from 1 to 39 in the pound.

TABLE.

	0	1	2	3	4	5	6	7	8	9
0	0	1.69	1.341	1.172	1.064	0.988	0.930	0.883	0.845	0.812
1	0.784	0.760	0.738	0.719	0.701	0.685	0.671	0.657	0.645	0.633
2	0.623	0.612	0.603	0.594	0.586	0.578	0.570	0.563	0.556	0.550
3	0.544	0.537	0.532	0.527	0.521	0.517	0.512	0.507	0.503	0.498

The upper horizontal column shews the number of bullets to a pound; the second, their diameters; the third, the diameters of those of 10, 11, 12, &c. and the fourth, those of 20, 21, 22, &c. and the last, those of 30, 31, 32, &c.

The government allows 11 bullets in the pound for the proof of muskets, and 14.5 in the pound, or 29 in two pounds for service; 17 for the proof of carabines, and 20 for service; and 28 in the pound for proof of pistols, and 34 for service.

The diameter of musket bullets differs but $\frac{1}{50}$th part from that of the musket-barrel; for if the shot but just rolls into the barrel, it is sufficient. Cannon bullets or balls are of different diameters and weights according to the nature of the piece.

BULLION, uncoined gold or silver in the mass.

Those metals are called so, either when smelted from the native ore, and not perfectly refined; or when they are perfectly refined, but melted down in bars or ingots, or in any unwrought body, of any degree of fineness.

When gold and silver are in their purity, they are so soft and flexible, that they cannot well be brought into any fashion for use, without being first reduced and hardened with an alloy of some other baser metal.

To prevent those abuses, which some might be tempted to commit in the making of such alloys, the legislators of civilized countries have ordained, that there shall be no more than a certain proportion of a baser metal to a particular quantity of pure gold or silver, in order to make them of the fineness of what is called the standard gold or silver of such a country.

According to the laws of England, all sorts of wrought plate in general ought to be made to the legal standard; and the price of our standard gold and silver is the common rule whereby to set a value on

their bullion, whether the same be in ingots, bars, dust, or in foreign specie; whence it is easy to conceive, that the value of bullion cannot be exactly known, without being first assayed, that the exact quantity of pure metal therein contained may be determined, and consequently whether it be above or below the standard.

Silver and gold, whether coined or uncoined (though used for a common measure of other things) are no less a commodity than wine, tobacco, or cloth; and may, in many cases, be exported as much to the national advantage as any other commodity.

BUMALDA, in botany, a genus of the Pentandria Digynia. Natural order of Dumosæ. Rhamni, Jussieu. Essential character; corolla five-petalled; styles villose; capsule two-celled, two-beaked. There is but one species; *viz.* B. trifolia, with a shrubby stem; branches close, in all parts smooth; branches obscurely angular, jointed, purple; leaves opposite, petioled, ternate, pale underneath, on very short capillary petioles, spreading very much, or reflex; flowers terminating the branches in racemes, or capillary peduncles. Native of Japan.

BUMELIA, in botany, a genus of the Pentandria Monogynia class and order. Essential character; corolla five cleft, with a five-leaved nectary; drupe one-seeded. There are seven species, all trees or shrubs, and natives of the West Indies.

BUNIAS, in botany, a genus of the Tetradynamia Siliquosa. Natural order of Siliquosæ. Cruciferæ, Jussieu. Essential character: silicle deciduous, four-sided, muricated with unequal acuminate angles. There are nine species, of which B. cornuta, horned bunias, is a very singular plant. It has silicle transversely oval, finishing on each side in a horn, or very long and strong spine, so that the silicle resembles a pair of horns; in the middle of the silicle are four small spines, directed different ways. It is a native of the Levant and Siberia. B. spinosa, thorny bunias, is an annual plant, and a native of the South of France, Switzerland, Austria, and Italy.

BUNIUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of umbellatæ. Essential character: cor. uniform; umbel crowded; fruits ovate. There is but one species, *viz.* B. bulbocastanum, earth nut, or pig nut, has a perennial, tuberous root, on the outside, of a chesnut colour, within white, solid, putting forth slender fibres from the sides and bottom, of an agreeable sweetish taste, lying deep in the ground, commonly four or five inches deep, the stems from the surface tapering towards it, flexuose or bending to and from, and of a white colour; the universal involucre consists seldom of more than one, two, or three very slender leaves, but in most instances is altogether wanting; the partial umbel has sometimes twenty rays; the petals are lanceolate, entire, but rolled inwards so as to appear as if they were emarginate; the filaments are longer than the petals; the pistils at first close, after divaricate, but never bend back. This description applies to the plant as usually found in Great Britain. That brunium which is most common in many parts of the continent is somewhat different from ours; the segments of the leaf are not so fine, and nearer to parsley, whereas ours approach to fennel. The root is not so far within the ground, the leaves are larger and greener, and it sends forth leaves from the bulb itself. With us it grows on heaths, in pastures, woods, and among bushes, in a gravelly or sandy soil: it flowers in May and June.

BUNT, *of a sail*, the middle part of it, formed designedly into a bag or cavity, that the sail may gather more wind. It is used mostly in top-sails, because courses are generally cut square, or with but small allowance for bunt or compass. The bunt holds much leeward wind, that is, it hangs much to leeward.

BUNT *lines* are small lines made fast to the bottom of the sails, in the middle part of the bolt rope, to a cringle, and so are reeved through a small block, seized to the yard. Their use is to trice up the bunt of the sail, for the better furling it up.

BUNTING. See EMBERIZA.

BUOY, at sea, a short piece of wood, or a close-hooped barrel, fastened so as to float directly over the anchor, that the men who go in the boat to weigh the anchor may know where it lies.

BUOY is also a piece of wood, or cork, sometimes an empty cask, well closed, swimming on the surface of the water, and fastened by a chain or cord to a large stone, piece of broken cannon, or the like, serving to mark the dangerous places near a coast, as rocks, shoals, wrecks of vessels, anchors, &c.

There are sometimes, instead of buoys, pieces of wood placed in form of masts, in conspicuous places; and sometimes large

trees are planted in a particular manner, in number two at least, to be taken in a right line, the one hiding the other, so as the two may appear to the eye no more than one one.

To BUOY *up the cable* is to fasten some pieces of wood, barrels, &c. to the cable, near the anchor, that the cable may not touch the ground, in case it be foul or rocky, lest it should be fretted and cut off.

BUPHAGA, the *African beef-eater*, in natural history, a genus of birds of the order of Picæ. Generic character: its bill is straight, and somewhat square; its mandibles are gibbous, entire, more gibbous externally, and its legs well formed for walking. It is found not only in Senegal, but near Caffraria. Its manners much resemble those of the starling. It feeds on various kinds of insects, and alighting on the backs of antelopes, sheep, and oxen, and by pressure on the elevated part of the hide, which contains the larvæ of the oestrus, forcing this out, greatly relieves the animal, and procures itself an exquisite banquet.

BUPHTHALMUM, in botany, a genus of the Syngenesia Polygamia Superflua. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: stigma of the hermaphrodite floscules undivided: seeds have the sides, especially in the ray, edged; down an obscure edge; receptacle chaffy. There are twelve species, of which, B. frutescens, shrubby ox-eye, rises with several woody stems from the root, and grows to the height of eight or ten feet, furnished with leaves very unequal in size, some of which are narrow and long, others broad and obtuse. The foot-stalks of the larger leaves have, on their upper side, near their base, two sharp teeth standing upward, and a little higher there are generally two or three more growing on the edge of the leaves. The flowers are produced at the ends of the branches single: these are of a pale yellow colour, and have scaly calyxes. It grows naturally in America. B. arborescens, tree ox-eye, seldom grows higher than three feet, sending out many stalks from the root, which are succulent; it has spear-shaped leaves placed opposite; the flowers are produced upon foot-stalks, which are two inches long. These flowers are larger than those of the first sort, of a bright yellow colour. They appear in July, August, and September. Some of these plants are shrubs, but most of them are herbs. The flowers are commonly terminating, and mostly of a yellow colour.

BUPLEURUM, in botany, a genus of the Pentandria Digynia. Natural order of Umbellatæ. Essential character: involucres of the umbellule larger, five-leaved; petals involuted; fruit roundish, compressed, striated. There are 19 species, of which B. rotundifolium, common thorough wax, so called from the singular circumstance of the stalk waxing or growing through the leaf; the root is annual, small, and fibrous; the stem a foot high, upright, round, perfectly smooth, alternately branched: every part of the plant is remarkably hard and rigid, and has a slight aromatic smell. It is a native of most parts of Europe. B. stellatum, starry hare's ear, has a perennial root, with a stem about 18 inches high, with long grass-like root-leaves, some ending obtusely, others drawing to a point; scarcely any on the stem, except one embracing leaf under a branch. Universal involucre of one, two, or three leaves. Partial involucre coloured, longer than the flowers, eight or nine-cleft at the edge, but united at bottom, so as to form a sort of basin in which the flowers are lodged. It is a native of the Alps, of Switzerland, and Dauphine. Most of the Bupleurums are herbaceous plants, some of them are shrubby, and one is thorny; the leaves are mostly simple and entire. The little flowers are yellow, and but few in an umbel. The involucre is many-leaved and short, though it has sometimes only three or five leaves. They are almost all of them natives of Switzerland and the South of France.

BUPRESTIS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ setaceous, of the length of the thorax; head half withdrawn beneath the thorax. This genus of insects is very conspicuous, on account of the superior brilliancy of its colours, with which many of the larger species shine with a metallic lustre. It is a very numerous genus, consisting, according to Gmelin, of 156 species. Among these we shall notice the B. gigantea, which is the largest hitherto discovered, measuring two inches and a half in length: the thorax is smooth, resembling the colour of polished bell-metal, and the wing-sheaths are of a gilded copper colour, with a cast of blue green. It is a native of India, China, and many other parts of Asia, and is also found in South America. Its beauty is so very singular, that the Chinese attempt to imitate it on bronze, in which they have

sometimes succeeded so well, that the copy has been mistaken for the reality. This insect proceeds from a large white larva resembling that of the lucanus cervus, or great stag-chaffer. Of the European insects of this genus the B. rustica is one of the largest, measuring about an inch and a half, and of a coppery colour, with several longitudinal furrows along the wing-shells; the thorax of a deep blue green, with numerous impressed points: it is found in the woods. The European Buprestes fall far short of the Indian and American species, both in point of size and splendour, though among them may be numbered several elegant insects.

BURCARDIA, in botany, so named in honour of Henry Burckhard, a genus of the Pentandria Pentagynia class and order. Essential character: calyx five-leaved; corolla five-petalled; capsule angular, one-celled, three-valved, seven or eight seeded. There is but one species, *viz.* B. villosa, an annual plant, with a branched stem two feet high, hirsute with reddish brown hairs. Flowers at the end of the stem and branches, axillary, solitary, on long hairy peduncles. The whole plant is covered with stiff hairs. It is found on the sandy coasts of Cayenne and Guiana.

BURDEN, or BURTHEN, in a general sense, implies a load or weight, supposed to be as much as a man, horse, &c. can well carry. A sound and healthy man can raise a weight equal to his own. An able horse can draw 350 *lb.* though for a length of time 300 *lb.* is sufficient. Hence calculations are formed by the artillery officers. One horse will draw as much as seven men.

BURDEN *of a ship* is it contents, or number of tons it will carry. The burden of a ship may be determined thus: multiply the length of the keel, taken within board, by the breadth of the ship within board, taken from the midship-beam, from plank to plank, and multiply the product by the depth of the hold, taken from the plank below the keelson, to the under part of the upper-deck plank, and divide the last product by 94, then the quotient is the content of the tonnage required.

BURGAGE, in law, a tenure proper to boroughs and towns, whereby the inhabitants hold their lands and tenements of the King, or other lord, at a certain yearly rate. This tenure is described by Glanvil, and is expressly said by Littleton to be but tenure in socage. It is indeed only a kind of town socage; as common socage, by which other lands are holden, is usually of a rural nature. A borough is usually distinguished from other towns by the right of sending members to parliament; and where the right of election is by burgage tenure, that alone is a proof of the antiquity of the borough. Tenure in burgage, therefore, or burgage tenure, is where houses, or lands which were formerly the scite of houses, in an ancient borough, are held by some lord in common socage, by a certain establishment. The free socage, in which these tenements are held, seems to be plainly a remnant of Saxon liberty; and this may account for the great variety of customs, affecting many of these tenements so held in ancient burgage; the principal and most remarkable of which is that called borough English; which see. There are also other special customs in different burgage tenures; as in some, that the wife shall be endowed of all her husband's tenements and not of the third part only, as at the common law: and in others, that a man might dispose of his tenements by will which in general was not permitted after the conquest, till the reign of Henry VIII.; though in the Saxon times it was allowable. A pregnant proof, says Judge Blackstone, that these liberties of socage tenure were fragments of Saxon liberty.

BURGESS, an inhabitant of a borough, or one who possesses a tenement therein. In other countries, burgess and citizen are confounded together; but with us they are distinguished: the word is also applied to the magistrates of some towns. Burgess is now ordinarily used for the representative of a borough-town in parliament.

BURGH-*bote* signifies a contribution towards the building or repairing of castles or walls, for the defence of a borough or city.

BURGLARY, in law, or nocturnal house-breaking, an unlawful entering into another man's dwelling, wherein some person is, or into a church, in the night-time; in order to commit some felony, or to kill some person, or to steal something thence, or do some other felonious act; whether the same be executed or not. This crime has been always regarded as very heinous; partly on account of the terror which it occasions, and partly because it is a forcible invasion and disturbance of that right of habitation, which every individual might require even in a state of nature, and against which the laws of civil society have particularly guarded. Whilst they allow the possessor to kill the aggressor, who attempts to

break into a house in the night time, they also protect and avenge him, in case the assailant should be too powerful. Such regard, indeed, has the law of England to the immunity of a man's house, that it stiles it his castle, and will never suffer it to be violated with impunity; for this reason no outward doors can in general be broken open to execute any civil process; though, in criminal cases, the public safety supersedes the private. Hence, also, in part, arises the animadversion of the law upon eaves-droppers, nuisancers, and incendiaries; and to this principle it must be assigned, that a man may assemble people together lawfully (at least if they do not exceed eleven) without danger of raising a riot, rout, or unlawful assembly, in order to protect and defend his house; which he is not permitted to do in any other case. The definition of a burglar, as given by Sir Edward Coke, is, "he that by night breaketh and entereth into a mansion-house with intent to commit a felony." In this definition, says Judge Blackstone, there are four things to be considered; the time, the place, the manner, and the intent. 1. The time must be by night, and not by day; for in the daytime there is no burglary. In considering what is reckoned night, the day was anciently accounted to begin at sun-rising and to end immediately upon sun-set: but the better opinion seems to be, that if there be daylight or twilight sufficient begun or left for discerning a man's face, it is no burglary. But this does not extend to moon-light: for then many midnight burglaries would go unpunished; and besides, the malignity of the offence does not so properly arise from its being done in the dark, as at the dead of night; when the whole creation, except beasts of prey, is at rest; when sleep has disarmed the owner, and rendered his castle defenceless. 2. As to the place. It must be by the definition a mansion-house; and, therefore, in order to account for the reason why breaking open a church is burglary, as it undoubtedly is, Sir Edward Coke quaintly observes, that it is "domus mansionalis Dei." But it is not necessary that it should in all cases be a mansion-house; for it may be committed by breaking the gates or walls of a town in the night. 3. As to the manner of committing burglary; there must be both a breaking and an entry to complete this offence. But they need not be done at once: for, if a hole be broken one night, and the same breakers enter the next night through the same, they are burglars. There must in general be an actual breaking, so that it may be regarded as a substantial and forcible irruption. Such are breaking, or taking out the glass of, or otherwise opening a window, and taking out goods; picking a lock, or opening it with a key; and lifting up the latch of a door, or loosing any other fastenings which the owner has provided. But if a person leaves his doors or windows of his house open, and a man enters by them, or with a hook or by any other means draws out some of the goods of the owner, it is no burglary; but if, having entered, he afterwards unlocks an inner or chamber door; or if he comes down a chimney, he is deemed a burglar. If a person enters by the open door of a house, and breaks open a chest and steals goods, this is no burglary by the common law, because the chest is no part of the house. 4. As to the intent; it is clear, that such breaking and entry must be with a felonious intent, otherwise it is only a trespass. And it is the same, whether such intention be actually carried into execution, or only demonstrated by some attempt or overt act, of which the jury is to judge.

BURGOMASTER, the chief magistrate of the great towns in Flanders, Holland, and Germany. The power and jurisdiction of the burgomaster is not the same in all places, every town having its particular customs and regulations: at Amsterdam there are four chosen by the voices of all those people in the senate, who have either been burgomasters or echevins. Their authority resembles that of the lord-mayor and aldermen; they dispose of all under offices that fall in their time, keep the key of the bank, and enjoy a salary but of 500 guilders, all feasts, public entertainments, &c. being defrayed out of the common treasury.

BURGUNDY *pitch*, in medicine, the juice of the pinus abies, boiled in water, and strained through a linen cloth. It is chiefly employed for external purposes in inveterate coughs, &c. Plasters of this resin, by acting as topical stimulants, are frequently found of considerable service.

BURIAL, the interment of a deceased person. The rites of burial make the greatest and most necessary care, being looked upon in all countries, and at all times, as a debt so sacred, that such as neglected to discharge it were thought accursed: hence the Romans called them *justa*, and the Greeks *νομιμα, δικαια, οσια, &c.* words implying the

inviolable obligations which nature has laid upon the living to take care of the obsequies of the dead. Nor are we to wonder that the ancient Greeks and Romans were extremely solicitous about the interment of their deceased friends, since they were strongly persuaded, that their souls could not be admitted into the Elysian fields till their bodies were committed to the earth; and if it happened that they never obtained the rites of burial, they were excluded from the happy mansions for the term of an hundred years. For this reason it was considered as a duty incumbent upon all travellers who should meet with a dead body in their way, to cast dust or mould upon it three times, and of these three handfuls one at least was cast upon the head. The ancients likewise considered it as a great misfortune if they were not laid in the sepulchres of their fathers; for which reason, such as died in foreign countries had usually their ashes brought home, and interred with those of their ancestors. But notwithstanding their great care in the burial of the dead, there were some persons whom they thought unworthy of that last office, and to whom therefore they refused it: such were, 1. Public or private enemies. 2. Such as betrayed, or conspired against their country. 3. Tyrants, who were always looked upon as enemies to their country. 4. Villains guilty of sacrilege. 5. Such as died in debt, whose bodies belonged to their creditors. And, 6. Some particular offenders, who suffered capital punishment.

Of those who were allowed the rites of burial, some were distinguished by particular circumstances of disgrace attending their interment: thus persons killed by lightning were buried apart by themselves, being thought odious to the gods; those who wasted their patrimony forfeited the right of being buried in the sepulchres of their fathers; and those who were guilty of self-murder were privately deposited in the ground, without the accustomed solemnities. Among the Jews, the privilege of burial was denied only to self-murderers, who were thrown out to rot upon the ground. In the Christian church, though good men always desired the privilege of interment, yet they were not, like the heathens, so concerned for their bodies, as to think it any detriment to them, if either the barbarity of an enemy, or some other accident, deprived them of this privilege. The primitive Christian church denied the more solemn rites of burial only to unbaptised persons, self-murderers, and excommunicated persons who continued obstinate and impenitent, in a manifest contempt of the church's censures.

The place of burial among the Jews was never particularly determined. We find they had graves in the town and country, upon the highways, in gardens, and upon mountains. Among the Greeks, the temples were made repositories for the dead in the primitive ages, yet the general custom in later ages with them, as well as with the Romans and other heathen nations, was to bury their dead without their cities, and chiefly by the highways. Among the primitive Christians, burying in cities was not allowed for the first three hundred years, nor in churches for many ages after, the dead bodies being first deposited in the atrium or church-yard, and porches and porticos of the church: hereditary burying-places were forbidden till the twelfth century.

Burials, in law, persons are to be buried in woollen, or their representatives shall forfeit 5*l.* and affidavit is to be made thereof before a justice under a like penalty.

Burials, as practised by the military, differ in some respects according to the rank of the deceased. The funeral of a field-marshal is saluted with three rounds of fifteen pieces of cannon, attended by six battalions and eight squadrons: that of a general, with three rounds of eleven pieces of cannon, four battalions and six squadrons; and so on, decreasing in honour, till that of a private which is attended by one serjeant, and thirteen rank and file, with three rounds of small arms. The pall is to be supported by officers of the same rank with that of the deceased. The order of march to be observed in military funerals is reversed with respect to rank. For instance, if an officer is buried in a garrison-town, or from a camp, it is customary for the officers belonging to the other corps to pay his remains the compliment of attendance; in which case the youngest ensign marches at the head immediately after the pall, and the general, if there be one, in the rear of the commissioned officers, who take their posts in reversed order, according to seniority. The battalion troop or company follow the same rule.

BURLESQUE, a jocose kind of poetry, chiefly used in the way of drollery and ridicule, to deride persons and things.

BURMANNIA, in botany, so named in

honour of John Burmann; a genus of the Hexandria Monogynia class and order. Natural order of Liliaceous Flowers. Coronariæ, Linnæus. Bromeliæ, Jussieu. Essential character; calyx prismatic coloured, trifid; angles membranous; petals three; capsule three-celled, straight; seeds minute. There are but two species; of which B. disticha has the root composed wholly of capillary fibres, very small. The plant has the appearance of an anthericum; root-leaves six, grass-like or ensiform, two inches long, quite entire; stem upright, simple, a span and half in height, having six or seven small alternate leaves an inch long; two equal divaricating spikes, each composed of about nine flowers, terminate the stem; the flowers are sessile, in a single row; they are blue, very elegant, and do not fall off. It is a native of Ceylon. B. biflora, has strong fibrous roots, with several oblong oval leaves arising from it, which are smooth and entire, four or five inches long; among these, springs the flower stem, six or eight inches high, terminating by blue flowers, growing together in each sheath. It is a native of Virginia and Carolina.

BURN, in medicine and surgery, an injury received in any part of the body, either by fire itself, or by instruments put in a violent heat by the fire. See SURGERY.

BURNING-*glass*, a convex or concave glass, commonly spherical, which being exposed directly to the sun, collects all the rays falling thereon into a very small space, called the focus; where wood, or any other combustible matter being put, will be set on fire. See OPTICS.

We have some extraordinary instances and surprizing accounts of prodigious effects of burning-glasses. Those made of reflecting mirrours are more powerful than those made with lenses, because the rays from a mirrour are reflected all to one point nearly; whereas by a lens, they are refracted to different points, and are therefore not so dense or ardent. The whiter also the metal or substance is, of which the mirrour is made, the stronger will be the effect.

The most remarkable burning-glasses, or rather mirrours, among the ancients, were those of Archimedes and Proclus; by the first of which the Roman ships, besieging Syracuse, according to the testimony of several writers, and by the other, the navy of Vitalian besieging Byzantium, were reduced to ashes. Among the moderns, the burning mirrours of greatest eminence, are those of Villette, and Tschirnhausen, and the new complex one of M. de Buffon.

That of M. de Villette, was three feet eleven inches in diameter, and its focal distance was three feet two inches. Its substance is a composition of tin, copper, and tin-glass. Some of its effects, as found by Dr. Harris and Dr. Desaguliers, are, that a silver sixpence melted in $7\frac{1}{2}''$; a King George's halfpenny melted in $16''$, and ran in $34''$; tin melted in $3''$, and a diamond weighing 4 grains, lost $\frac{3}{4}$ths of its weight.

That of M. de Buffon is a polyhedron, six feet broad, and as many high, consisting of 168 small mirrours, or flat pieces of looking-glass, each six inches square; by means of which, with the faint rays of the sun in the month of March, he set on fire boards of beech wood at 150 feet distance. Besides, his machine has the conveniency of burning downwards, or horizontally, as one pleases; each speculum being moveable, so as, by the means of three screws, to be set to a proper inclination for directing the rays towards any given point; and it turns either in its greater focus, or in any nearer interval, which our common burning-glasses cannot do, their focus being fixed and determined. M. de Buffon, at another time, burnt wood at the distance of 200 feet. He also melted tin and lead, at the distance of above 120 feet, and silver at 50.

Mr. Parker, of Fleet-street, London, was induced, at an expense of upwards of 700*l.* to contrive and at length to complete a large transparent lens, that would serve the purpose of fusing and vitrifying such substances as resist the fires of ordinary furnaces, and more especially of applying heat in vacuo, and in other circumstances in which it cannot be applied by any other means. After directing his attention for several years to this object, and performing a great variety of experiments in the prosecution of it, he at last succeeded in the construction of a lens, of flint-glass, three feet in diameter, which, when fixed in its frame, exposes a surface two feet $8\frac{1}{2}$ inches in the clear, without any other material imperfection besides a disfigurement of one of the edges by a piece of the scoria of the mould, which unfortunately found its way into its substance. This lens was double convex, both sides of which were a portion of a sphere of 18 feet radius. It is difficult to form an accurate estimate of the burning power of this lens; inasmuch as it is next to impossible to discover what should be deducted for the loss of power, in conse-

quence of the impediments that the glass of which it was made must occasion, as well as the four reflections and two more by way of diminution; but we will endeavour to appreciate it after making a full allowance for these deductions, which must necessarily result from every means of concentrating the solar rays, and which must be considered to be as the friction of an engine, of which nature they really partake. The solar rays received on a circular surface of 2 feet $8\frac{1}{2}$ inches, when concentrated within the diameter of an inch will be 1056.25 times its intensity, or this number of times greater than the heat of the sun as felt on the surface of the earth. We will suppose that as the heat of the air, in ordinary summer weather, is 65°, and in sultry weather is 75°, the average of which is 70°, and that we take this degree as the average effect, the accumulated power of the lens, on the supposition of an equal effect over the whole surface of the focus, will be equal to 73938°.

It must be recollected by those who have had an opportunity of examining the effects of this lens, that the external part of the focal light was less intense than that part which was near the centre of it; or rather, that the effect was very much accumulated in the centre; but as it is possible that the refraction of the light and of the caloric fluid may not take place in the same angles, we think it safest to consider it as of an uniform effect, and after deducting one-fourth part thereof as a compensation, there remains 55454°, as the expression of its power. As the application of the second lens reduced the diameter of the focus to half an inch, the effect, without allowing for the reduction of its power, would be equal to 221816°, but deducting one-fourth for the second transmission, there remains 166362°, as the expression of its power.

Mr. Parker farther informs us that a diamond, weighing 10 grains, exposed to this lens for 30 minutes, was reduced to 6 grains; during which operation it opened, and foliated like the leaves of a flower, and emitted whitish fumes, and when closed again it bore a polish and retained its form. Gold remained in its metallic state without apparent diminution, notwithstanding an exposure at intervals of many hours: but what is remarkable, the rest, or cupel, which was composed of bone-ash, was tinctured with a beautiful pink colour.

The experiments on platina evince that the specimens were in different states of approach to a complete metallic form; several of them threw off their parts in sparks, which in most instances were metallic. Copper, after three minutes exposure, was not found to have lost in weight.

What is remarkable with regard to experiments on iron, is, that the lower part, *i. e.* that part in contact with the charcoal, was first melted, when that part which was exposed to the focus remained unfused: an evidence of the effect of flux on this metal.

Several of the semi-crystalline substances, exposed to the focal heat, exhibited symptoms of fusion: such as the agate, oriental flint, cornelian, and jasper; but as the probability is that these substances were not capable of complete vitrification, it is enough that they were rendered externally of a glassy form. Garnet completely fused on black-lead in 120″, lost $\frac{1}{4}$th of a grain, became darker in colour, and was attracted by the magnet. Ten cut garnets taken from a bracelet began to run the one into the other in a few seconds, and at last formed into one globular garnet. The clay used by Mr. Wedgwood to make his pyrometric test run in a few seconds into a white enamel. Seven other kinds of clay sent by Mr. Wedgwood were all vitrified. Several experiments were made on limestone, some of which were vitrified, but all of which were agglutinated; it is, however, suspected that some extraneous substance must have been intermixed. A globule produced from one of the specimens, on being put into the mouth, flew into a thousand pieces, occasioned, it is presumed, by the moisture.

Some experiments were made in the year 1802, with Mr. Parker's lens, with the view of ascertaining whether the moon communicated any heat to the earth, in common with the reflected light from which we derive so much advantage. This experiment was attended by Sir Joseph Banks, with several members of the Royal Society, together with Dr. Crawford, who provided the most sensible thermometers; but after applying them to the luminous focus, so far from a perceptible increase of heat, it was thought there was perceived rather a diminution thereof; but this suspicion did not lead them to a fair investigation of the fact. Since this period some experiments have been made, that evince the power of communicating cold by reflection; but as this fact has not yet been explained consistently with the present received theory,

we shall content ourselves with taking notice of the experiment made by M. Pictet. Two concave mirrors being placed at the distance of $10\frac{1}{2}$ feet from each other, a very delicate air thermometer was put into one of the foci, and a glass matrass full of snow in the other. The thermometer sunk several degrees, and rose again when the matrass was removed. When nitric acid was poured upon the snow (which increased the cold) the thermometer sunk 5° or 6° lower. Here cold seems to have been emitted by the snow, and reflected by the mirrors to the thermometer, which it is thought could not happen unless cold were a substance. It has been found that upon an admixture of equal quantities of snow, which is always at 32°, and of water heated to 172°, the result is that the compound only retains the lowest heat of 32°, so that 140° of heat or caloric disappears. Much has been said respecting the point or degree at which the thermometer should indicate the presence of heat. The experiments of Dr. Crawford seem to place it at 1268° below the present 0; Mr. Kirwan places it at 1048°; Messrs. Lavoisier and La Place at 2736°; and by a mixture of four parts of sulphuric acid with three pints of water, it seems that it should be placed at 5803° below 0. Experiments of this kind may be made *ad infinitum*, and in time it may possibly be ascertained that cold is a real substance; but for the purpose of getting an answer to the present question, we will accommodate the scale of Fahrenheit, by adding 108° thereto, so as to make the 0 correspond with the caloric imbibed by snow or ice before it can melt.

The superficies of spherical bodies are to each other as the squares of their respective diameters. The diameter of the moon is considered to be 2180 miles, and its mean distance from the earth 240,000; from which it follows, on the supposition that all the solar rays received by the moon were reflected back, and that the earth was absolutely without heat, that the effect of this reflection would be found to be .00367 of a degree (for $\overline{240,000 \times 2} : 178° :: \overline{2180}^2 :$ .00367); which multiplied into 1056.25, and this sum increased four times for the increased power of the second lens, would give 15.51234° as the heat of the focus; 92.28766° below the present 0, or 124.28766° below the freezing point. This dissertation is interesting in another point of view, for this calculation ascertains that the light afforded by the moon, when compared with that by the sun, abtracting all impediments in both cases, is only as 1 to 43480.

A subscription was proposed for raising the sum of 700 guineas, towards indemnifying the charges of the inventor, and retaining the very curious and useful machine above described in our own country; but from the failures of the subscription, and some other concurring circumstances, Mr. Parker was induced to dispose of it to Capt. Mackintosh, who accompanied Lord Macartney in the embassy to China; and it was left, much to the regret of philosophers in Europe, at Pekin; where it remains in the hands of persons, who most probably know neither its value nor use.

BURNING-*mountains*, the same with volcanos. See VOLCANO.

BURNISHER, a round polished piece of steel, serving to smooth and give a lustre to metals.

Of these there are different kinds of different figures, straight, crooked, &c. Half burnishers are used to solder silver as well as to give a lustre.

BURNISHING, the art of smoothing or polishing a metalline body by a brisk rubbing of it with a burnisher.

Book-binders burnish the edges of their books by rubbing them with a dog's tooth. Gold and silver are burnished by rubbing them with a wolf's tooth, or by the bloody stone, or by tripoli, a piece of white wood, emery, and the like. Deer are said to burnish their heads by rubbing off a downy white skin from their horns against a tree.

BURR *pump*, or BILDGE *pump*, differs from the common pump in having a staff 6, 7, or 8 feet long, with a bar of wood whereto the leather is nailed, and this serves instead of a box. So two men standing over the pump thrust down this staff, to the middle whereof is fastened a rope for 6, 8, or 10 to hale by, thus pulling it up and down.

BURSARIA, in natural history, a genus of worms of the order Infusoria. Worm very simple, membranaceous, hollow. There are three species, *viz.* the truncatella, hirundinella, and duplella, found in marshy water; the first has a white body, oval, with a large hollow descending to the base, with sometimes four or five eggs at the bottom; the second is a pellucid hollow membrane, moving forwards like a bird in flight; the third is found among duck-weed, without visible intestines.

BURSARS, in the Scotch universities, are youths chosen as exhibitioners, and

maintained for the space of four years at the rate of 100*l.* per ann. Scots.

BURSE, in a commercial sense, a place for merchants to meet in and negociate their business publicly, with us called exchange.

BURSERA, in botany, so called in honour of Joachim Burser, a genus of the Polygamia Dioecia. Essential character: Herm. calyx three-leaved; corolla three-petalled; capsule fleshy, three-valved, one-seeded. Male, calyx five-toothed; corolla five-petalled; stamina ten. There is but one species, *viz.* B. gummifera, Jamaica birch tree, is very lofty, with an upright, round, smooth trunk, covered with a livid shining bark, peeling off in round pieces, like the European birch; branches terminating, smooth, horizontal; flowers small and white; capsule red, resembling a drupe. On the male trees the flowers are more copious, and crowded in the racemes, but are scarcely larger. This tree is common in all the sugar islands of the West Indies. The bark is very thick and exudes a clear transparent resin, which soon hardens in the air. It flowers from May to July. With us it has not flowered, although it has been cultivated since the year 1690.

BUSH, *burning*, that bush wherein the Lord appeared to Moses at the foot of Mount Horeb, as he was feeding his father-in-law's flocks. As to the person that appeared in the bush the scripture, in several places, calls him by the name of God: he says of himself, "that he is the Lord, the God who is the God of Abraham, Isaac, and Jacob, &c." And Moses, blessing Joseph, says, "let the blessing of him that dwelt in the bush come upon the head of Joseph." But the Hebrew and the Greek septuagint import that the angel of the Lord appeared to him. St. Stephen, and several others, read it in the same manner; and, moreover, some say that it was an angel that represented the Lord: yet there are persons hold the son of God to be the person that appeared in the bush.

The Mahometans believe that one of Moses's shoes, put off by him as he drew near the burning-bush, was placed in the ark of the covenant in order to preserve the memory of this miracle.

BUSHEL, a measure of capacity for dry things, as grain, fruits, dry pulse, &c. containing four pecks, or eight gallons, or one-eighth of a quarter.

A bushel, by 12 Henry VII. c. 5, is to contain eight gallons of wheat; the gallon eight pounds of troy weight; the ounce twenty sterlings; and the sterling thirty-two grains, or corns of wheat growing in the midst of the ear. See MEASURE and WEIGHT.

BUSKIN, a kind of shoe, somewhat in manner of a boot, and adapted to either foot, and worn by either sex.

This part of dress, covering both the foot and mid-leg, was tied underneath the knee; it was very rich and fine, and principally used on the stage by actors in tragedy. It was of a quadrangular form, and the sole was so thick as that by means thereof men of the ordinary stature might be raised to the pitch and elevation of the heroes they personated. The colour was generally purple on the stage: herein it was distinguished from the sock worn in comedy, that being only a low common shoe. The buskin seems to have been worn not only by actors, but by girls to raise their height; travellers and hunters also made use of it to defend themselves from the mire.

In classic authors we frequently find the buskin used to signify tragedy itself, because it was a mark of tragedy on the stage.

It is also sometimes understood for a lofty strain, or high style.

BUSS, in maritime affairs, a small sea vessel, used by us and the Dutch in the herring fishery, commonly from forty-eight to sixty tons burden, and sometimes more: a buss has two small sheds or cabins, one at the prow, and the other at the stern; that at the prow serves for a kitchen. Every buss has a master, an assistant, a mate, and seamen in proportion to the vessel's bigness; the master commands in chief, and without his express order, the nets cannot be cast nor taken up; the assistant has the command after him; and the mate next, whose business is to see the seamen manage their rigging in a proper manner, to mind those who draw in their nets, and those who kill, gut, and cure the herrings, as they are taken out of the sea. The seamen generally engage for a whole voyage in the lump. The provisions which they take on board the busses, consist commonly in biscuit, oatmeal, and dried or salt fish; the crew being content for the rest with what fresh fish they catch.

BUST, or BUSTO, in sculpture, &c. a term used for the figure or portrait of a person in relievo, shewing only the head, shoulders, and stomach, the arms being lop-

ped off: it is usually placed on a pedestal or console. The bust is the same with what the Latins called *herma*, from the Greek *Hermes*, Mercury, the image of that god being frequently represented in that manner by the Athenians.

BUST, *communicative*. See ACCOUSTICS.

BUSTARD, in ornithology. See OTIS.

BUTCHER, a person who slaughters cattle for the use of the table, or who cuts up and retails the same. Among the ancient Romans there were three kinds of established butchers, whose office was to furnish the city with the necessary cattle, and to take care of preparing and vending their flesh. The suarii provided hogs; the pecuarii, or boarii, other cattle, especially oxen; and under these was a subordinate class, whose office was to kill, called lanii, and carnifices.

To exercise the office of butcher among the Jews with dexterity, was of more reputation than to understand the liberal arts and sciences. They have a book concerning shamble-constitution; and in case of any difficulty, they apply to some learned rabbi for advice: nor was any allowed to practise this art without a licence in form; which gave the man, upon evidence of his abilities, a power to kill meat, and others to eat what he killed; provided he carefully read every week for one year, and every month the next year, and once a quarter during his life, the constitution above-mentioned.

In London, the furnishing of butcher's meat is separated into different trades. We have carcass-butchers, who kill the meat in great quantities, and sell it to others, who retail it among their customers. Besides these, there are salesmen who attend the markets at Smithfield, and who act between the carcass butcher and the breeder and feeder of cattle in the country. The butchers were incorporated into a company in the third year of James I.

BUTCHER *bird*, in ornithology. See LANIUS.

BUTCHER'S *broom*, in botany. See RUSCUS.

BUTEA, in botany, a genus of the Diadelphia Decandria class and order. Calyx slightly two-lipped; corolla with a very long lanceolate banner; legume compressed, membranaceous; one-seeded at the tip. Two species; *viz*. Frondosa and Superba, found on the coast of Coromandel.

BUTLER, the name anciently given to an officer in the court of France, being the same as the grand echanson, or great cupbearer of the present times.

BUTLER, in the common acceptation of the word, is an officer in the houses of princes and great men, whose principal business is to look after the wine, plate, &c.

BUTLERAGE *of wine*, is a duty of two shillings for every ton of wine imported by merchants strangers; being a composition in lieu of the liberties and freedoms granted to them by King John and Edward I., by a charter called charta mercatoria. Butlerage was originally the only custom that was payable upon the importation of wines, and was taken and received by virtue of the regal prerogative, for the proper use of the crown. But for many years past, there having been granted by parliament subsidies to the kings of England, and the duty of butlerage not repealed, but confirmed, they have been pleased to grant away to some nobleman, who, by virtue of such grant, is to enjoy the full benefit and advantage thereof, and may cause the same to be collected in the same manner that the kings themselves were formerly wont to do. The name was derived from the circumstance of the duty being formerly paid to the king's butler.

BUTMENTS, in architecture, those supporters or props on or against which the feet of arches rest.

BUTT, in commerce, a vessel or measure of wine, containing four hogsheads, or two hundred and fifty-two gallons.

BUTT, or BUTT-*ends*, in the sea language, are the fore-ends of all planks under water, as they rise, and are joined one end to another. Butt-ends in great ships are most carefully bolted; for if any one of them should spring or give way, the leak would be very dangerous and difficult to stop.

BUTTER, a fat unctuous substance, prepared from milk, by heating or churning it. It was late before the Greeks appear to have had any notion of butter; their poets make no mention of it, and yet are frequently speaking of milk and cheese. The Romans used butter no otherwise than as a medicine, never as a food. The ancient Christians of Egypt burnt butter in their lamps instead of oil; and in the Roman churches it was anciently allowed, during Christmas time, to burn butter instead of oil, on account of the great consumption of it other ways. See MILK.

BUTTER, is a name given in the old chemistry to several metallic muriates, on

account of their texture when newly prepared. According to this system, there are the butters of antimony, arsenic, bismuth, and tin. They all agree in the following particulars: they are formed by sublimation; their texture is not unlike that of butter in warm weather; they are decomposable by being dropped into pure water, a precipitation of white oxide taking place. There are likewise vegetable butters, a term applied to those vegetable expressed oils that require a greater heat than that of the atmosphere to keep them in a fluid state: of these the palm oil is best known: a similar oil may be obtained from the cocoa nut; and the celebrated Park found in Africa a tree, called by the natives shea, from the fruit of which a tolerably pure butter was obtained.

BUTTER *milk*, a kind of serum that remains behind, after the butter is made.

BUTTERFLY, the English name of a numerous genus of insects, called by zoologists papilio. See PAPILIO.

BUTTERY, a room in the houses of noblemen and gentlemen, belonging to the butler, where he deposits the utensils belonging to his office, as table-linen, napkins, pots, tankards, glasses, cruets, salvers, spoons, knives, forks, pepper, mustard, &c.

BUTTNERIA, in botany, so named from David Sigismunda Augustus Buttner; a genus of the Pentandria Monogynia class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character; corolla five-petalled; filaments at the top connate with the petals; capsule five-grained, muricate. There are three species; *viz.* B. scabra, is a perennial plant, from three to five feet high, with alternate, long, angular branches, armed with cartilaginous prickles; at the axils of the leaves, stem, and branches, the flowers are produced singly on short peduncles: it is found at Cayenne. B. carthaginensis is a shrub branching and spreading on every side, in manner of the common bramble; racemes short, aggregate, and axillary on the young branches; flowers without smell, white, and very numerous: native of Carthagena and St. Domingo; flowering in September and October: and B. microphylla differs but little from the foregoing, in having the trunk and branches larger and round, the peduncles one-flowered, and the corolla purple and white, variegated: it was found in the island of St. Domingo by Jacquin, and brought into Europe.

BUTTOCK *of a ship*, is that part of her which is her breadth right a-stern, from the tack upwards; and a ship is said to have a broad or a narrow buttock, according as she is built, broad or narrow at the transum.

BUTTOMUS, in botany, a genus of the Enneandria Hexagynia. Natural order of Tripetaloideæ. Junci, Jussieu. One of the connecting links between lilies and rushes. Essential character; calyx none; petals six; capsule six, many-seeded. There is but one species; *viz.* B. umbellatus, flowering rush or gladiole, has a perennial root; leaves ensiform, long, triangular, smooth, quite entire, spongy, at bottom sheathing, at top flat and twisted; flowers to thirty, each on a single, round, smooth peduncle, from an inch to about a finger's length, forming an upright umbel, surrounded at bottom by an involucre of three withering membranous sheaths, besides a smaller stipule to each peduncle; corolla very handsome and large, of a bright flesh colour; filaments placed on a regular circle on the receptacle; the pollen is of a bright yellow colour; germ nearly triangular. This is the only plant of the class Enneandria which grows wild in Britain.

BUTTON, an article of dress, serving to fasten cloaths tight about the body, made of metal, silk, mohair, &c. in various forms. Metal buttons are either cast in moulds, in the manner of other small works, or made of thin plates of gold, silver, or brass, whose structure is very ingenious.

Of the manufacture of metal buttons. These are originally formed in two different ways; the blanks are either pierced out of a large sheet of metal with a punch driven by a fly-press, or cast in a pair of flasks of moderate size, containing 10 or 12 dozen each. In this latter case, the shanks are previously fixed in the sand, exactly in the centre of the impression formed by each pattern, so as to have their extremities immersed in the melted metal when poured into the flask, by which means they are consequently firmly fixed in the button when cooled. The former process is generally used for yellow buttons, and the latter for those of white metal. We shall first give an instance of the former mode of procedure as used in the manufacture of gilt buttons. The gilding metal is an alloy of copper and zinc, containing a smaller proportion of the latter than ordinary brass, and is made either by fusing together the copper and zinc, or by fusing brass with the requisite additional proportion of copper. This

metal is first rolled into sheets of the intended thickness of the button, and the blanks are then pierced out as before mentioned. The blanks thus formed are, when intended for plain buttons, usually planished by a single stroke of a plain die driven by the same engine, the fly-press: when for ornamented buttons, the figure is frequently also struck in like manner by an appropriate die, though there are others which are ornamented by hand. The shanks, which are made with wonderful facility and expedition by means of a very curious engine, are then temporarily attached to the bottom of each button by a wire clamp like a pair of sugar-tongs, and a small quantity of solder and resin applied to each. They are in this state exposed to heat on an iron plate containing about a gross, till the solder runs, and the shank becomes fixed to the button, after which they are put singly in a lathe, and their edges turned off smoothly. The surface of the metal, which has become in a small degree oxydated by the action of the heat in soldering, is next to be cleaned, which in this, as in a great variety of other instances in the manufacture of metallic articles, is effected by the process of dipping or pickling; that is, some dozens of them are put into an earthen vessel, pierced full of holes like a cullender; the whole dipped into a vessel of diluted nitric acid; suffered to drain for a few seconds, again dipped successively into four or five other vessels of pure water, and then dried.

The next operation is the rough burnishing, which is performed by fixing the buttons in the lathe, and applying a burnisher of hard black stone from Derbyshire: the minute pores occasioned by the successive action of the heat and the acid are thus closed, and the subsequent process of gilding considerably improved, both with regard to economy and perfection. The first step towards the gilding of all the alloys of copper consists in covering the surface uniformly with a thin stratum of mercury, by which means the amalgam, which is afterwards applied, attaches itself to it much more readily than it would otherwise do. This part of the process is called quicking, and is effected by stirring the buttons about with a brush, in a vessel containing a quantity of nitric acid supersaturated with mercury, which latter is, of course, by the superior elective attraction of the copper for the acid, precipitated in its metallic state on the buttons, whose surfaces become uniformly and brilliantly covered with it. The mercury, which hangs in loose drops on the buttons, is then shaken off, by jerking the whole violently in a kind of earthen cullender made for the purpose, and they are then ready for receiving the amalgam. The amalgam is made by heating a quantity of grain gold with mercury in an iron ladle, by which means the former is soon dissolved, and the whole is then poured into a vessel of cold water. The superabundant mercury is strongly pressed out through a piece of chamois leather, and the remaining amalgam, which is of about the consistence of butter, is then fit for application. This is performed by stirring the buttons, whose surfaces are already thinly covered or wetted with mercury, in an earthen vessel, with the requisite proportion of amalgam and a small quantity of diluted nitric acid, by which means the amalgam also attaches itself to their surfaces with a considerable degree of equality. The necessary quantity of gold is about five grains to a gross of buttons of an inch in diameter.

The next process is the volatilization of the mercury by heat, which is usually called by the workmen drying off. This is performed by first heating the buttons in an iron pan, somewhat like a large frying-pan, till the amalgam with which they are covered becomes fluid, and seems disposed to run into drops, on which they are thrown into a large felt cap, called a gilding cap, made of coarse wool and goats' hair, and stirred about with a brush to equalize the covering of the surface by the gold. After this they are again heated, again thrown into the gilding cap, and stirred, and these operations successively repeated till the whole of the mercury is volatilized. When the mercury is volatilized from the buttons, or, as the workmen denominate it, when the buttons are dried off, they are finally burnished, and are then finished and fit for carding.

The white metal buttons, which are composed of brass, alloyed with different proportions of tin, after having been cast as before mentioned, are polished by turning them in a lathe, and applying successively pieces of buffalo skin glued on wood, charged with powdered grindstone and oil, rotten stone, and crocus martis. They are then white-boiled, that is, boiled with a quantity of grain tin in a solution of crude red tartar, or argol, and, lastly, finished with a buff with finely prepared crocus.

Glass buttons. These articles are also frequently wholly composed of glass of various colours, in imitation of the opal, lapis lazuli, and other stones. The glass is in this case kept in fusion, and the button nipped out of it whilst in its plastic state, by a pair of iron moulds, like those used for casting pistol shot, adapted to the intended form of the button; the workmen previously inserting the shank into the mould, so that it may become imbedded in the glass when cold.

Mother of pearl buttons. This substance is also frequently used in the manufacture of buttons: in which case, the mode of fixing in the shank is somewhat ingenious. It is done by drilling a hole at the back which is under-cut; that is, larger at the bottom than the top, like a mortise, and the shank being driven in by a steady stroke, its extremity expands on striking against the bottom of the hole, and it becomes firmly rivetted into the button. To these foil-stones are also frequently added, in which case, they are usually attached with isinglass-glue. Steel studs are also often rivetted into buttons of this and various other kinds.

The practice of wearing buttons consisting merely of a mould covered with the same kind of cloth as the garment itself, being at present extremely general, it may, perhaps, be proper to remark, that this is prohibited on pain of pecuniary penalties, from 40*s.* to 5*l.* per dozen, by several statutes which have been made at different times for the promotion of this manufacture, and under which several convictions have taken place within a few years.

BUTTRESS, a kind of butment built archwise, or a mass of stone or brick, serving to prop or support the sides of a building, wall, &c. on the outside, where it is either very high, or has any considerable load to sustain on the other side, as a bank of earth, &c.

BUXBAUMIA, in botany, a kind of moss, of which there are only two species. Both are to be found in the dissertation of the younger Linnæus on mosses.

BUXUS, in botany, a genus of the Monoecia Tetrandria class and order. Natural order of Tricoceæ. Euphorbiæ, Jussieu. Essential character: male calyx three-leaved; petals three; styles three; capsule three-beaked; three-celled; seeds two. There is but one species; *viz.* B. sempervirens, box-tree, is well known in its dwarf state and as a shrub, about three feet in height. The wood is of a yellow colour, very hard and ponderous. It is the only one of the European woods which will sink in water. The leaves are ovate in the common sort, hard, smooth, glossy, evergreen, very dark green above, and pale green underneath, like those of myrtle, but blunt and emarginate at the end; from the axils of the leaves come out the small herbaceous flowers, in round bunches; a female flower occupying the middle of the bunch, being surrounded by several males.

The female flower is succeeded by a capsule of a globular form, very smooth, shining, tricoccous, and before it opens having three beaks resembling a tripod; the cocculi or grains are of the consistence of paper, two-valved, and opening with an elastic spring; receptacle central, three-sided, and short; in each cell is a pair of seeds, ovate, growing more slender upwards; triangular-compressed, obliquely truncate at the end, of a blackish brown colour. The wood of the box-tree sells at a very high price, by weight, being very hard and smooth, and not apt to warp. It is a native of most parts of Europe, from Britain southwards.

BY-LAWS, or BYE-LAWS, private and peculiar laws for the good government of a city, court, or other community, made by the general consent of the members. All by-laws are to be reasonable, and for the common benefit, not private advantage of any particular persons, and must be agreeable to the public laws in being. If made by corporations, they are to be approved by the Lord Chancellor or Chief Justice, or justices of assize, on pain of 40*l.* if against the good of the public. But it is said, a corporation cannot make by-laws without a custom for it, or the king's charter; nor may they make any by-law to bind strangers that live out of their corporation, or to restrain a person from working in or setting up his trade, though it may be for the order and regulating of trades; and notwithstanding such a by-law may inflict a reasonable penalty, which may be recovered by distress or action of debt, yet none can be imprisoned upon it, as it is contrary to Magna Charta.

BYRLAW, or BURLAW *laws*, in Scotland, are made and determined by neighbours, elected by common consent in byrlaw courts. The men, chosen as judges, are called byrlaw or burlaw-men, and take cognizance of complaints between neighbour and neighbour.

BYRRHUS, in natural history, a genus of insects of the order Coleoptera: generic

character; antennæ longer than the head, clavate, the club perfoliate; feelers equal, subclavate; jaw and lip bifid. There are about 12 species found in different parts of Europe. The B. scrophularia is a small insect of the size of the lady-bird; its colour is dark brown, clouded with broken or irregular white bands, and the edges, constituting the line of division between the wing sheaths, are red. This insect is found more frequently on the plant called scrophularia aquatica than elsewhere. B. pilula is a larger species, equalling or rather exceeding the size of the common lady-bird; it is of an extremely convex shape, and when disturbed contracts its limbs, and lies in an inert state, resembling the appearance of a seed or pill. It is found on various plants, and about garden-grounds, &c. The antennæ in this species are longer than in others, and rather foliated than merely knobbed.

BYSSUS, in botany, a genus of the Cryptogamia Algæ, and the last in the scale of vegetation in that class. They appear in the form of threads, on rotten wood, the bark of trees, rocks, and walls, especially in damp cellars, one sort is common on wine casks, at first is like flakes of snow, but turns yellow, in this state it has black grains at the base like gunpowder. The green paper byssus is a farina concreting on the surface of the water, and forming a wide thin film. There are many species, but the number is doubtful.

BYSTROPOGON, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order, Verticillatæ. Labiatæ, Jussieu. Essential character: calyx five-subulate, bearded at the opening; corolla, upper lip bifid; covers trifid; stamens distant. There are seven species, of which B. pectinatum balm-leaved bystropogon has an herbaceous stem, generally five or six feet high, leaves petioled, cordate, veined; spikes simple or manifold; scarcely leafy; composed of whorls; supported by several bristle-shaped bractes, the length of the flowers, which grow thick together, curiously disposed on the smaller slips of the branched tops; they are whitish, and all the parts very small; the neck of the calyx and filaments are commonly covered with down. The corolla is scarcely larger than the calyx; stamens the length of the corolla and distant; style purplish; stigmas simple, seeds roundish, black and glossy. This plant is a native of Jamaica. It is found in all the low lands about Kingston and Spanish Town.

C.

C, the third letter, and second consonant of the alphabet, is formed by forcing the breath between the tongue, elevated near the palate (to make the voice somewhat sibilous) with the lips open. It has two sounds, hard and soft; hard, like k before a, u, o, l, and r; as in call, cost, cup, clean, crop; and soft, like s before i, e, and y; as in city, cession, cyder: before h it has a peculiar sound, as in chance, chalk: in chord, chart, and some other words, it is hard like k: but in many French words it is soft before h, like s, as in chaise, chagrin.

As a numeral, C signifies 100, CC 200, &c.

C, in music, the highest part in the thorough base; again, a simple C, or rather a semicircle, placed after the cliff, intimates, that the music is in common time, which is either quick or slow, as it is joined with allegro or adagio: if alone, it is usually adagio.

If the C be crossed or turned, the first requires the air to be played quick, and the last very quick.

CAABA, or CAABAH, properly signifies a square building; but is particularly applied by the Mahometans to the temple of Mecca, built, as they pretend, by Abraham and Ishmael his son. It is towards this temple they always turn their faces when they pray, in whatever part of the world they happen to be.

This temple enjoys the privilege of an asylum for all sorts of criminals; but it is most remarkable for the pilgrimages made to it by the devout Mussulmen, who pay so great a veneration to it, that they believe a

single sight of its sacred walls, without any particular act of devotion, is as meritorious, in the sight of God, as the most careful discharge of one's duty, for the space of a whole year, in any other temple.

CAB, an Hebrew dry measure equal to $2\frac{5}{6}$ pints of our corn measure.

CABBAGE. See BRASSICA.

CABBAGE *tree*. See ARECA.

CABBAGING, among gardeners, a term used for the knitting of cabbages into round heads.

CABBALA, properly signifies tradition, and is the name of a mysterious kind of science, thought to have been delivered by revelation to the ancient Jews, and transmitted by oral tradition to those of our times; serving for the interpretation of the books both of nature and scripture.

The Cabbala is properly the oral law of the Jews, delivered down by word of mouth from father to son; and it is to these interpretations of the written law, that our Saviour's censure is to be applied, when he reproves the Jews for making the commands of God of none effect, through their traditions.

CABBALISTS, the Jewish doctors, who profess the study of the cabbala. In the opinion of these men, there is not a word, letter, or accent in the law, without some mystery in it. The Jews are divided into two general sects; the Karaites, who refuse to receive either tradition or the talmud, or any thing but the pure text of scripture; and the rabbinists, or talmudists, who, besides this, receive the traditions of the ancients, and follow the talmud. The latter are again divided into two other sects; pure rabbinists, who explain the scripture, in its natural sense, by grammar, history, and tradition; and cabbalists, who, to discover hidden mystical senses, which they suppose God to have couched therein, make use of the cabbala, and the mystical methods above mentioned.

CABECA, or CABESSE, a name given to the finest silks in the East Indies.

CABIN, in the sea language, a small room or apartment, whereof there are a great many in several parts of a ship; particularly on the quarter-deck, and on each side of the steerage, for the officers of the ship to lie in. The great cabin is the chief of all, and that which properly belongs to the captain or chief commander.

CABINET, the most retired place in the finest part of a building, set apart for writing, studying, or preserving any thing that is precious. A complete apartment consists of a hall, anti-chamber, chamber, and cabinet, with a gallery on one side. Hence we say a cabinet of paintings, curiosities, &c.

CABINET, in natural history. This term is applied with some latitude to any small or select collection of natural curiosities, without regarding whether the articles it comprises be contained within a cabinet or not. Thus, for instance, it is not unfrequent with us to speak of cabinets of animals, cabinets of birds, of fishes, reptiles, and other similar articles, as a mode of expressing such an assemblage of natural history as may not be of sufficient importance to deserve the epithet of a museum. The word cabinet, in its usual acceptation with the naturalist, is not therefore confined solely to the boxes, press, or chest of drawers, in which articles of curiosity are contained, but implies at once both the repository itself, and the articles arranged in it.

Cabinets of fossils, shells, and corals have the drawers sometimes divided for this purpose into small compartments, by means of an inner frame work, that lets into the bottom of the drawer; but trays of various sizes, made either of card or pasteboard, have a much neater appearance, and are preferred by many as being more commodious, and more easily shifted from one part of the drawer to another, as the addition of new acquisitions in any particular tribe or genus may require. Nothing can be more desirable than to have the cabinets well made, that the drawers may slide with perfect ease in their proper recesses in the press. The drawers should fit so close, when shut up, as to preclude the entrance of dust of any kind. The cabinet itself should be also placed in a dry situation, as there are few articles of natural history that are not affected in a greater or less degree by an excess of damp, or even heat. The drawers are uniformly made shallow, the bottom of each is lined with cork, and the top is covered with glass, through which the insect may be seen without being exposed to the air, or accidents that would arise from their being touched by the incautious spectator.

Cabinets for insects are built of various sizes, from those which contain ten or a dozen drawers to others that include above an hundred. They are usually of mahogany, but it is immaterial whether they be made of mahogany or wainscot; some have them

of cedar, but seldom of deal, or any other wood of a soft texture. The drawers may be from fifteen to thirty inches in length, the same, or nearly the same, in breadth, and about two or three inches in depth. The cork with which the bottoms are lined must be chosen as free from cracks and holes as possible; it should be also glued into the drawers to prevent its warping, and be filed or cut very level; and after this the irregularities on the surface of the cork should be rubbed down with pumice-stone, till the whole is rendered perfectly smooth, before the paper is pasted over it. The paper should be of a fine smooth and even grain, but neither very stout nor highly stiffened with size, lest it should turn the points of the pins, when placing the insects in the drawers. The top of every drawer must be covered with a plate of glass, to prevent the admission of dust or air. This plate is usually fitted into a frame of the same size as the drawer, and is made either to slide in a groove, or let in on a rabbet; the latter contrivance is much the best, because in sliding the glass along the groove, if any of the pins happen to stand so high as to touch the frame-work, the insects will be injured by the jerk, or, as more frequently happens in this case, be broken to pieces. On the contrary, when the frame falls in upon a rabbet, it is of no consequence whether the edge of the frame sinks into the drawer below the level of the heads of the pins on which the insects are placed or not; it is only necessary to observe, that the glass does not press upon the pins, since it is the glass only that can come in contact with them.

CABLE, a thick, large, strong rope, commonly of hemp, which serves to keep a ship at anchor.

There is no merchant ship, however weak, but has, at least, three cables; namely, the chief cable, or cable of the sheet-anchor, a common cable, and a smaller one.

Cable is also said of ropes which serve to raise heavy loads by the help of cranes, pullies, and other engines. The name of cable is usually given to such as are, at least, three inches in diameter; those that are less are only called ropes of different names, according to their use.

Every cable, of what thickness soever it be, is composed of three strands, every strand of three ropes, and every rope of three twists; the twist is made of more or less threads, according as the cable is to be thicker or thinner.

In the manufacture of cables, after the ropes are made, they use sticks, which they pass first between the ropes of which they make the strands, and afterwards between the strands of which they make the cable, to the end that they may all twist the better, and be more regularly wound together; and also to prevent them from twining or entangling, they hang at the end of each strand and of each rope a weight of lead or of stone.

The number of threads each cable is composed of is always proportioned to its length and thickness; and it is by this number of threads that its weight and value are ascertained; thus a cable of three inches circumference, or one inch diameter, ought to consist of 48 ordinary threads, and weigh 192 pounds; and on this foundation is calculated the following table, very useful for all people engaged in marine commerce, who fit out merchant-men for their own account, or freight them for the account of others.

A table of the number of threads and weight of cables of different circumferences.

Circumf.	Threads.	Weight.
3 inches.	48	192 pounds.
4	77	308
5	121	484
6	174	696
7	238	952
8	311	1244
9	393	1572
10	485	1940
11	598	2392
12	699	2796
13	821	3284
14	952	3808
15	1093	4372
16	1244	4976
17	1404	5616
18	1574	6296
19	1754	7016
20	1943	7772

CABLE, *sheet anchor*, is the greatest cable belonging to a ship.

CABLE, *to splice a*, is to make two pieces fast together, by working the several threads of the rope, the one into the other.

CABLE, *pay more*, is to let more out of the ship. *Pay cheap the cable*, is to hand it out apace. *Veer more cable*, is to let more out, &c.

CABLED, in heraldry, a term applied to a cross, formed of the two ends of a ship's

cable; sometimes also to a cross covered over with rounds of rope, more properly called a cross-corded.

CABOCHED, in heraldry, is when the heads of beasts are borne without any part of the neck, full faced.

CACALIA, in botany, a genus of the Syngenesia Polygamia class and order. Natural order of Compositæ Discoideæ: Corymbiferæ, Jussieu. Essential character: calyx cylindric, oblong, at the base only subcalycled; down capillary; receptacle naked. There are thirty-three species, of which we shall only give a short description of two or three. C. papillaris, or rough stalked cacalia, has the foot stalk very strong and thick, and is set round on every side, being destitute of leaves, with three truncated foot stalks; and thus is the stem defended in a singular manner from external injuries. It is a native of the Cape of Good Hope, and is cultivated in England, but has never yet produced flowers. C. suaveolens, sweet-scented cacalia, has a perennial creeping root, sending out many stalks; these rise to the height of seven or eight feet, are streaked, quite simple, and terminated by corymbs of white flowers; the peduncles above the ramifications have bristle-shaped bractes scattered over them, which are smooth. It is a native of Virginia and Canada; flowering in August, and ripening its seeds in October. The roots which have been cast out of the Chelsea gardens have been carried by the tide to a great distance, and lodged on the banks of the rivers, and fastened themselves to the ground, where they have increased so much as almost to appear as if they were natives. C. articulata, jointed stalked cacalia, is an elegant plant, smooth and glaucous, of an unpleasant flavour; stems many, fleshy, round, upright but weak, marked with scars from the fallen leaves, and painted with lines of a deep green; florets twenty-five, a little longer than the calyx, white, with border acute and spreading much; anthers dark purple; stigma bifid, yellow; seeds linear, crowned with a white sessile egret. Found at the Cape of Good Hope. It flowers in November.

CACAO, the *chocolate tree*, in botany. See Theobroma.

CACHRYS, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit subovate, angular, suberous, cortical. There are five species, of which C. libanotis, smooth-seeded cachrys, has a thick fleshy root like fennel, which runs deep into the ground, sending out several narrow pinnate leaves, ending in many points; between these arises a smooth jointed stalk, about three feet high, which is terminated by large umbels of yellow flowers. Native of Sicily. C. tenuifolia, five-leaved cachrys: root perennial, fleshy, gratefully aromatic, with branches an inch thick, a cubit in length, covered with a smooth bark; umbels almost a span in diameter, consisting of from sixteen to twenty rays, about two inches in length; flowers yellow. Native of Montpellier, flowering in May.

CACTUS, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Succulentæ. Cacti, Jussieu. Essential character: calyx one-leafed, superior, imbricate; corolla manifold; berry one-celled, many-seeded. There are twenty-seven species. This genus consists of succulent plants, permanent in duration, singular and various in structure; generally without leaves, having the stem or branches jointed; for the most part armed with spines in bundles, with which, in many species, bristles are intermixed. The bundles of spines are placed on the top of the tubercles in the C. mammillaris, smaller melon thistle, which is tubercled all over, and produces its flowers between the tubercles. In C. melocactus, great melon thistle, or turk's cap, the spines are ranged in a single row on the ridge of the ribs; when it is cut through the middle, the inside is found to be a soft green, fleshy, substance, very full of moisture. The flowers and fruit are produced in circles round the upper part of the cap. C. pitajaya, torch thistle, or torch wood, is upright, and grows to the height of eight or ten feet. The flower is whitish, very handsome, but has scarcely any smell; it is half a foot in diameter, and blows in the night. The fruit is of the form and size of a hen's egg, of a shining scarlet colour on the outside; the pulp is white, fleshy, sweet, eatable, full of small black seeds. C. grandiflorus, great flowering creeping cereus; and C. flagelliformis, pink flowering creeping cereus, are the same with those already mentioned, except that the stems are weak, and cannot support themselves; they therefore seek assistance, and throw out roots from the stem like ivy. C. moniliformis, necklace Indian fig; the branches are jointed, and very much flatted; the bundles

of spines or bristles are scattered over the surface, and the flowers are produced from the edge of the branches. C. phyllanthus, spleenwort-leaved Indian fig, has the branches much thinner, and may be fairly denominated leaves; they are indented along the edge, and the flowers come out singly from the indentures. The fruit in some of the sorts is small, like currants, but in most it is large and shaped like a fig; whence their name of Indian fig. These singular plants are all natives of the continent of South America and the West Indian islands.

CADENCE, in music, according to the ancients, is a series of a certain number of notes, in a certain interval, which strike the ear agreeably, and especially at the end of the song, stanza, &c. It consists ordinarily of three notes. Cadence, in the modern music, may be defined a certain conclusion of a song, or of the parts of a song, which divide it, as it were, into so many numbers or periods. It is when the parts terminate in a chord or note, the ear seeming naturally to expect it; and is much the same in a song as the period that closes the sense in a paragraph of a discourse. See MUSIC.

CADENCE, in rhetoric and poetry, the running of verse or prose, otherwise called the numbers, and by the ancients ῥυθμος.

CADENCE, in dancing, is when the several steps and motions follow, or correspond, to the notes and measures of the music.

CADENCE is used as a military term, and implies a very regular and uniform method of marching, by the drum and music: it may not, says a good writer on this subject, be improperly called mathematical marching; for after the length of the step is determined, the time and distance may be found.

CADET is a military term, denoting a young gentleman who chooses to carry arms in a marching regiment as a private man. His views are to acquire some knowledge in the art of war, and to obtain a commission in the army. Cadet differs from volunteer, as the former takes pay, whereas the latter serves without any pay. There is a company of gentlemen cadets maintained at Woolwich, at the King's expense, where they are taught all the sciences necessary to form a complete officer.

CADI, or CADHI, a judge of the civil affairs in the Turkish empire. It is generally taken for the judge of a town: judges of provinces being distinguished by the appellation of mollas.

CADIA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-cleft; petals five, equal, obcordate; legume many-seeded. There is but one species; *viz.* C. purpurea, purple flowered cadia, is a shrub rising to the height of three feet. The leaves are pinnate, coming out alternately; leaflets from 15 to 30 pairs, linear, retuse, the nerve ending in a little point. The corolla is rose coloured, or rather the colour of a peach blossom; legume somewhat less than a span in length, containing eight or ten seeds. It is a native of Arabia.

CADUCI, in botany, the name of a class of plants in Linnæus's Methodus Calycina, consisting of plants of which the calyx is a simple perianthium, supporting a single flower, or fructification, and falling off either before or with the petals. It stands opposed to the Persistentes, in the same method, and is exemplified in mustard, sinapi, and ranunculus. The term caducous is expressive of the shortest period of duration, and has different acceptations, according to the different parts of plants to which it is applied. A calyx is said to be caducous, which drops at the first opening of the petals, or even before, as in the poppy. Petals are caducous which are scarcely unfolded before they fall off, as in the meadow rue; and such leaves have obtained this denomination as fall before the end of the summer.

CADUS, in antiquity, a wine vessel of a certain capacity, containing 80 amphoræ, or firkins, each of which, according to the best accounts, held nine gallons.

CÆCUM, or CŒCUM, in anatomy, the blind gut, or first of the thick intestines. See ANATOMY.

CÆNOPTERIS, in botany, a genus of the Cryptogamia Filices. Generic character: fructifications in submarginal lateral lines, covered with a membrane gaping on the outside. There is but one species; *viz.* C. rhizophylla, common peduncle or rachis, round, brown, and smooth, elongated at the tip, leafless; bulbiferous rooting; partial peduncles green, flatted, sometimes winged. Fructifications in short, solitary, lateral lines, beginning at the nerve towards the base of the pinnules, and covered with an entire scariose brown membrane. Native of the island of Dominica.

CÆSALPINA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ,

Jussieu. Essential character: calyx five-parted, the lowest segment longer, and slightly arched; stamen woolly at the base; petals five; legume compressed. There are eight species, of which C. elata is a tree with bipinnate leaves of seven pairs; the leaflets fifteen pairs, quite entire, minute: flowers large, and of a yellow colour: filaments very dark purple, villose at the base. It is a native of India. C. pulcherrima, the Barbadoes flower fence, rises with a straight stalk ten or twelve feet high: it is covered with a smooth grey bark: it divides into several spreading branches at the top, arched at each joint with two short, strong, crooked spines. The branches are terminated by loose spikes of flowers, which are sometimes formed into a kind of pyramid, and at others they are disposed more in form of an umbel. The peduncle of each flower is nearly three inches long. The petals are roundish at the top; they spread open, and are beautifully variegated with a deep red or orange colour, yellow, and some spots of green, and have a very agreeable odour. This beautiful plant is a native of both Indies. It is planted in hedges to divide the lands in Barbadoes, whence it has the name of flower-fence.

CÆSAR, in Roman antiquity, a title borne by all the emperors, from Julius Cæsar to the destruction of the empire. It was also used as a title of distinction for the intended or presumptive heir of the empire, as king of the Romans is now used for that of the German empire. This title took its rise from the surname of the first emperor, C. Julius Cæsar, which, by a decree of the senate, all the succeeding emperors were to bear. Under his successor, the appellation of Augustus being appropriated to the emperors, in compliment to that prince, the title Cæsar was given to the second person in the empire, though still it continued to be given to the first; and hence the difference betwixt Cæsar used simply, and Cæsar with the addition of Imperator Augustus.

CÆSARIAN *section*, in midwifery, a chirurgical operation, by which the fœtus is delivered from the womb of its mother, when it cannot be done in the natural way. See MIDWIFERY.

CÆSULIA, in botany, a genus of the Syngenesia Æqualis. Receptacle chaffy; seeds involved in the chaff; calyx three-leaved. Two species; *viz.* C. axillaris, a native of the East Indies, and C. radicans, a native of Guinea.

CÆSURA, in the ancient poetry, is when, in the scanning of a verse, a word is divided so, as one part seems cut off, and goes to a different foot from the rest; as,

Menti|ri no|li, nun|quam men|dacia | prosunt.

where the syllables *ri, li, quam,* and *men,* are cæsuras.

Cæsura more properly denotes a certain and agreeable division of the words between the feet of a verse, whereby the last syllable of a word becomes the first of a foot; as in

Arma virumque cano, Trojæ qui primus ab oris.

where the syllables *no* and *jæ* are cæsuras.

CÆSURA, or CÆSURE, in the modern poetry, denotes a rest, or pause, towards the middle of an Alexandrine verse, by which the voice and pronunciation are aided, and the verse, as it were, divided into two hemistichs. In Alexandrine verses of twelve or thirteen syllables, the cæsure must always be on the sixth; in verses of ten, on the fourth; and in those of twelve on the sixth: verses of eight syllables must not have any cæsure.

CÆTERIS *paribus*, a Latin term, often used by mathematical and physical writers, the words literally signifying "the rest, or the other things, being alike, or equal." Thus we say, the heavier the bullet, "cæteris paribus," the greater the range: *i. e.* by how much the bullet is heavier; if the length and diameter of the piece, and the quantity and strength of the powder be the same, by so much will the utmost range or distance of a piece of ordnance be greater. Thus also, in a physical way, we say, the velocity and quantity of the blood circulating, in a given time, through any section of an artery, will, "cæteris paribus," be according to its diameter, and nearness to, or distance from the heart.

CAILLE (NICHOLAS LEWIS DE LA), in biography, an eminent French mathematician and astronomer, was born in the diocese of Rheims in 1713. His father having quitted the army, in which he had served, amused himself in his retirement with studying mathematics and mechanics, in which he proved the happy author of several inventions of considerable use to the public. From this example of his father, our author almost in his infancy took a fancy to mechanics, which proved of signal service to him in his maturer years. At school he discovered early tokens of genius. He next came to Paris in 1729, where he

studied the classics, philosophy, and mathematics. He afterwards studied divinity in the College de Navarre, with the view of embracing the ecclesiastical life, but never entered into priest's orders. His turn for astronomy soon connected him with the celebrated Cassini, who procured him an apartment in the observatory: where, assisted by the counsels of this master, he soon acquired a name among the astronomers. In 1739 he was joined with M. Cassini de Thury, son to M. Cassini, in verifying the meridian through the whole extent of France; and in the same year he was named professor of mathematics in the College of Mazarine. In 1741 he was admitted into the Academy of Sciences, and had many excellent papers inserted in their memoirs; beside which, he published several useful treatises, *viz.* Elements of Geometry, Astronomy, Mechanics, and Optics. He also carefully computed all the eclipses of the sun and moon that had happened since the christian æra, which were printed in the work entitled, "L'Art de verifier les Dates," &c. Paris, 1750, in 4to. He also compiled a volume of astronomical ephemerides for the years 1745 to 1755; another for the years 1755 to 1765; and a third for the years 1765 to 1775: as also the most correct solar tables of any; and an excellent work entitled, "Astronomiæ Fundamenta novissimis Solis et Stellarum Observationibus stabilita."

Having gone through a seven years' series of astronomical observations in his own observatory in the Mazarine College, he formed the project of going to observe the southern stars at the Cape of Good Hope; being countenanced by the court, he set out upon this expedition in 1750, and in the space of two years he observed there the places of about 10,000 stars in the southern hemisphere that are not visible in our latitudes, as well as many other important elements, *viz.* the parallaxes of the sun, moon, and some of the planets, the obliquity of the ecliptic, the refractions, &c. Having thus executed the purpose of his voyage, and no present opportunity offering for his return, he thought of employing the vacant time in another arduous attempt; no less than that of taking the measure of the earth, as he had already done that of the heavens, whence he discovered, that the radii of the parallels in south latitude are not the same length as those of the corresponding parallels in north latitude. About the 23d degree of south latitude he found a degree on the meridian to contain 342222 Paris feet. The court of Versailles also sent him an order to go and fix the situation of the Isles of France and of Bourbon.

M. de la Caille returned to France in the autumn of 1754, after an absence of about four years; loaded, not indeed with the spoils of the East, but with those of the southern heavens, before then almost unknown to astronomers. Upon his return, he first drew up a reply to some strictures which the celebrated Euler had published relative to the meridian; after which he settled the results of the comparison of his observations for the parallaxes, with those of other astronomers: that of the sun he fixed at $9\frac{1}{2}''$; of the moon at $56' 56''$; of Mars in his opposition, $36''$; of Venus $38''$. He also settled the laws by which astronomical refractions are varied by the different density or rarity of the air, by heat or cold, and by dryness or moisture. And, lastly, he shewed an easy and practicable method of finding the longitude at sea by means of the moon. His fame being now celebrated every where, M. de la Caille was soon elected a member of most of the academies and societies of Europe, as London, Bologna, Petersburgh, Berlin, Stockholm, and Gottingen. He died in 1762, aged 49.

CAISSON, in the military art, a wooden chest, into which several bombs are put, and sometimes only filled with gunpowder: this is buried under some work, whereof the enemy intend to possess themselves, and when they are masters of it, is fired, in order to blow them up.

CAISSON is also used for a wooden frame, or chest, used in laying the foundations of the piers of a bridge.

The practice of building in caissons is a method sometimes adopted in laying the foundation of bridges in very deep or rapid rivers. These are large hollow vessels framed of strong timbers, and made watertight, which being launched and floated to a proper position in the river, where the ground has been previously excavated and levelled, are there sunk. The piers of the bridge are then built within them, and carried up above, or nearly to the level of the water, when the sides of the caisson are detached from the bottom, and removed: the bottom, composed of a strong grating of timber remaining, and serving for a foundation to the pier. The most considerable work, where caissons have been used, was in the building of Westminster-bridge; of these, therefore, a particular account may

be acceptable. Each of the caissons contained 150 loads of fir timber, and was of more tonnage than a man of war of 40 guns; their size was nearly 80 feet from point to point, and 30 feet in breadth; the sides, which were 10 feet in height, were formed of timbers laid horizontally over one another, pinned with oak trunnels, and framed together at all the corners, except the salient angles, where they were secured by proper iron-work, which being unscrewed, would permit the sides of the caisson, had it been found necessary, to divide into two parts. These sides were planked across the timbers, inside and outside, with 3-inch planks, in a vertical position. The thickness of the sides was 18 inches at bottom, and 15 inches at top; and in order to strengthen them the more, every angle, except the two points, had three oaken knee timbers properly bolted and secured. These sides, when finished, were fastened to the bottom or grating, by 28 pieces of timber on the outside, and 18 within, called straps, about 8 inches broad, and about 3 inches thick, reaching and lapping over the tops of the sides; the lower part of these straps were dove-tailed to the outer curb of the grating, and kept in their places by iron wedges. The purpose of these straps and wedges was, that when the pier was built up sufficiently high above low-water-mark, to render the caisson no longer necessary for the masons to work in, the wedges being drawn up, gave liberty to clear the straps from the mortices, in consequence of which the sides rose by their own buoyancy, leaving the grating under the foundation of the pier. The pressure of the water upon the sides of the caisson was resisted by means of a ground timber or ribbon, 14 inches wide and 7 inches thick, pinned upon the upper row of timbers of the grating; and the top of the sides was secured by a sufficient number of beams laid across, which also served to support a floor on which the labourers stood to hoist the stones out of the lighters, and to lower them into the caisson. The caisson was also provided with a sluice to admit the water. The method of working was as follows: A pit being dug and levelled in the proper situation for the pier of the same shape as the caisson, and about five feet wider all round; the caisson was brought to its position, a few of the lower courses of the pier built in it, and sunk once or twice to prove the level of the foundation; then, being finally fixed, the masons worked in the usual methods of tide-work. About two hours before low water, the sluice of the caisson, kept open till then, lest the water, flowing to the height of many more feet on the outside than the inside, should float the caisson and all the stone-work out of its true place, was shut down, and the water pumped low enough, without waiting for the lowest ebb of the tide, for the masons to set and cramp the stone-work of the succeeding courses. Then, when the tide had risen to a considerable height, the sluice was opened again, and the water admitted; and as the caisson was purposely built but 16 feet high to save useless expense, the high tides flowed some feet above the sides, but without any damage or inconvenience to the works. In this manner the work proceeded till the pier rose to the surface of the caisson, when the sides were floated away to serve the same purpose at another pier.

CAKILE, in botany, *sea-rocket*, a genus of the Tetrandia Siliculosa class and order. Silicle lanceolate, somewhat four-sided, consisting of two deciduous joints, without valves, and each containing a single seed; the lower joint with a tooth on each side at the tip. There are two species, *viz.* C. maritima, found on the sea-coast of England, and C. Ægyptiaca, a native of Italy and Egypt.

CALAGUALA *root*, brought from America for medicinal purposes, and has acquired considerable reputation on the continent. It is supposed to be obtained from a species of polypodium. Its colour is brown, and partly covered with scales like the roots of fern, and is hard and difficult to reduce to powder. It is asserted by Vauquelin that it contains

Woody fibre	Colouring matter
Gum	Malic acid
Resin	Muriate of potash
Sugar	Lime
Starch	Silica.

The mode of analysis may be thus described. Alcohol dissolves the resin and sugar. By evaporating the solution to dryness, and treating the residue with water, the sugar is separated, and the resin left. Water dissolved the gum and the muriate of potash, which were obtained by evaporation. Diluted nitric acid dissolved the starch and colouring matter, and let fall the former when mixed with four times its bulk of alcohol. The woody fibre remained, which when incinerated left carbonate of lime, muriate of potash, and a little silica. As

the decoction reddened vegetable blues, it is possible that the lime was in combination with malic acid.

CALAMANCO, a sort of woollen stuff manufactured in England and in Brabant. It has a fine gloss, and is chequered in the warp, whence the checks appear only on the right side. Some calamancoes are quite plain, others have broad stripes adorned with flowers; some with plain broad stripes, some with narrow stripes, and others watered.

CALAMARIÆ, in botany, the name of a third order in Linnæus's "Fragments of a Natural Method." This order will be easily distinguished from the family of grasses, by recollecting, 1. That the base of the leaf, which embraces the stalk like a glove, has no longitudinal aperture in plants of this order, but is perfectly entire; 2. The stalk is generally triangular, and without knots or joints; 3. The flowers have no petals.

CALAMINARIS, or *lapis calaminaris*, a mineral containing zinc, united with iron and other substances. It is heavy, hard, and brittle, or of a consistence between stone and earth. The colour is whitish or grey, sometimes inclining to yellow, and sometimes to black. It is found in great plenty in many parts of Europe; but the best is obtained in this country. It seldom lies deep, and in many parts it is found mixed with lead ores. Calamine is the only true ore from which zinc is obtained by calcination. See Zinc.

CALAMUS, in botany, a genus of the Hexandria Monogynia class and order. Natural order Tripetaloideæ. Palmæ, Jussieu. Essential character: calyx six-leaved; corolla none; berry dried, one-seeded, imbricate backwards. According to Martyn, there is but one species, though Loureiro has discriminated six; *viz.* C. rotang, rattan, has a perennial stem, quite simple or unbranched, without any tendrils: leaves alternate, sublanceolate, quite entire, scarcely a foot long: flowers commonly hermaphrodite, almost terminating on one spadix or more. The rattan seems to form the connecting link between the palms and the gramineous plants, having the flower of the former, but the habit of the latter. The palm called raphia has the embryo placed in the same manner, namely, on a lateral cavity of the horny albumen; in the fruit and spadix it agrees nearly with this in form, only they are much larger: the flowers differ but little, except that they are monoecous, as the flowers of the rattan probably are.

CALCAR *corollæ*, in botany, the spur of the corolla. The nectarium so called, which terminates the corolla behind, like a cock's spur, in valerian, orchis, violet, balsam, larkspur, &c.

CALCEOLARIA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Corydales. Scrophulariæ, Jussieu. Essential character; corolla ringent, inflated; capsule two-celled, two-valved; calyx four-parted, equal. There are seven species, of which C. pinnata, pinnated slipper-wort, has an annual root; stem erect, two feet high, round, brittle, with a thick down, and from sixteen to twenty joints; flowers from each top and stalk double; corollas yellow; upper-lip subglobular, inflated, emarginate in front, with a cleft for the prominent anthers; capsule thin, from a swelling base, diminishing to a pyramidal top; seeds very small, almost cylindric, streaked: native of Peru, in moist places.

CALCINATION, in chemistry. A substance is said to be calcined when it has been exposed to heat of a sufficient intensity to drive off every thing volatile, but short of that by which it might be fused: a calx, therefore, was formerly understood to be a pulverulent substance, no longer combustible, or capable of further alteration by fire than that of vitrification. As most metals were found to be reducible to such a form by the continuance of the melting heat, the term "calces of metals" was long appropriated to them, and is still partially retained, though it has been chiefly supplanted by the more characteristic appellation of oxide, which expresses the peculiar change that occurs in metallic bodies by the absorption of oxygen. Calcination expresses the mode by which, in metals, this change is produced, and oxydation the circumstance of change. It is, however, improper to consider the term calcination as synonymous with oxydation, even in speaking of metals, since the former term implies the agency of fire; whereas oxydation may be produced as well by the action of acids, as by heat and air.

CALCITRAPA, in botany, a genus of the Tetrandia Monogynia class and order: calyx four-cleft; corolla four-cleft; berry four-seeded. There are twelve species, found in both Indies, Cochin-China, and Japan.

CALCULATION, the act of computing several sums, by adding, subtracting, multiplying, or dividing. See ARITHMETIC.

An error in calculation is never protected or secured by any sentence, decree, &c. for in stating accounts it is always understood that errors of calculation are excepted.

CALCULATION is more particularly used to signify the computations in astronomy and geometry, for making tables of logarithms, ephemerides, finding the time of eclipses, &c.

CALCULATION, in music: many eminent mathematicians suppose that a good ear and strong hand on instruments, where the tone depends on the performer, are the musician's best guide, without having recourse to calculation. On this subject the celebrated D'Alembert says, "It is an achievement of no small importance to have deduced the principal facts to a system from one experiment, *viz.* the harmonies of a single string. Calculation may, indeed, facilitate the intelligence of certain points of theory, such as the relation between the tones of the gamut and temperament; but the calculation necessary for treating these two points is so simple and trifling that it merits no display. Let us not, therefore, imitate those musicians who believe themselves geometricians, or those geometricians who fancy themselves musicians, and in their writings heap figures on figures, imagining, perhaps, that this display is necessary to the art." See D'ALEMBERT.

CALCULI, *biliary*, in chemistry, are small stones found in the gall-bladder, and probably formed by the changes produced on the bile while it remains in that organ. These are not uniform in their appearance, but vary in colour, texture, and hardness. The most common are of a lamellated structure, resembling spermaceti, disposed in crystalline laminæ, which have a close resemblance in their properties to ADIPOCIRE, which see. Biliary calculi are soluble in oil of turpentine; but more completely in the fixed alkalies, by which they are reduced to a saponaceous state. Ammonia, unless in the boiling state, has little effect upon them. Nitric acid dissolves them, forming a liquid similar to the oil of camphor, which becomes concrete, and without and crystalline structure, and is more soluble in ether, and the alkalies than the original matter. This substance is contained in a greater or less degree in nearly all the human biliary calculi; hence they partake of its properties; are fusible, inflammable, and more or less soluble in the re-agents which dissolve it. Other calculi are occasionally found in the gall-bladders of quadrupeds, which have been supposed to consist of inspissated bile; they are irregular, and of various forms. Gall-stones in general are distinguished for their lightness and inflammability, few of them being so heavy as to sink in water, and when put to a lighted candle they usually melt like wax, and kindle with a bright flame, attended with an ammoniacal smell.

CALCULI, *urinary*, concretions formed in the kidney or bladder; and composed in greater or smaller proportions, of the following substances, *viz.* uric acid, urate of ammonia, phosphate of lime, phosphate of ammonia and magnesia, oxalate of lime, silex and animal albumen. These principles being more or less common, and in different proportions, give rise to numerous varieties.

The calculi most common are those composed of uric acid; they are generally of a brown or yellowish colour, smooth on the surface, and with a texture compact or radiated; they are perfectly soluble in alkaline solutions, and give a red colour when treated with nitric acid. Dr. Wollaston has arranged the urinary calculi under four species, *viz.* 1. The uric acid concretion: 2. The fusible calculus, or phosphate of ammonia and magnesia: 3. The mulberry calculus, or oxalate and phosphate of lime; And, 4. the bone earthy calculus, composed of phosphate of lime, which forms the basis of bone. Fourcroy and Vauquelin have given a different arrangement: they affirm that in all calculi there exists a quantity of animal matter which appears to connect their particles; but independently of this, which is common to the whole, they compose three genera; the first contains three species, each formed of one ingredient: the second comprises seven species, formed of two ingredients each: and in the third there are two species, consisting of three or four ingredients; this system is exhibited in the following table:

Genus I.	Species 1.	Calculus of	uric acid.
	.... 2.	....	urate of ammonia.
	.... 3.	....	oxalate of lime.
Genus II.	.... 4.	....	uric acid and earthy phosphates, in distinct layers.
	.... 5.	....	uric acid and earthy phosphates, intimately mixed.
	.... 6.	....	urate of ammonia and phosphates, in distinct layers.
	.... 7.	....	urate of ammonia and phosphates, intimately mixed.
	.... 8.	....	earthy phosphates, either mixed intimately or in fine layers.
	.... 9.	....	oxalate of lime and uric acid, in distinct layers.
	.... 10.	....	oxalate of lime and earthy phosphates, in distinct layers.
Genus III.	.... 11.	....	uric acid, or urate of ammonia, earthy phosphates, and oxalate of lime.
	.... 12.	....	uric acid, urate of ammonia, earthy phosphates, and silex.

It becomes a question of great importance and interest to mankind how far the solution of calculi in the bladder may be practicable. From what has been said it is evident that being of very different chemical composition the same solvent cannot be applicable to all of them. Long experience has sufficiently established the advantage of alkaline remedies; and as the calculi composed of uric acid are questionably the most abundant, it is no doubt from the chemical action they exert upon it that the benefit is derived. Lime, under the form of lime-water, has been employed as a solvent; and from some experiments of Dr. Egan, it should seem that lime water acts with more energy than an alkaline solution of similar strength, in destroying the aggregation of urinary concretion. Mr. Murray bears his testimony to the same fact: "I observed," says he, "this effect strikingly displayed in a comparative trial which these experiments led me to make. In a dilute solution of pure potassa, a calculus of the uric acid kind was in part dissolved, the liquor, after a short time, giving a copious white precipitate with muriatic acid; but the remaining calculus preserved its aggregation, apparently without much alteration, the external layer having been merely removed; while a calculus of a similar kind, and discharged from the person, immersed in lime-water, became in a few days white and spongy: it appeared at length to be entirely penetrated; its cohesion was subverted; it presented a kind of loose scaly appearance, and the least touch made it fall down. The lime probably operates more upon the albumen or animal matter, which appears to serve as the cement or connecting substance, than upon the uric acid; and in endeavouring to discover solvents for these concretions, our views ought perhaps rather to be directed to this operation than to the effect on the saline matter. If lime when received into the stomach under the form of lime-water, can be secreted by the kidneys, as the alkalis unquestionably are, it would appear from these observations to be superior to them as a solvent."

CALCULUS denotes a method of computation, so called from the calculi, or counters, anciently used for this purpose.

Calculus *specialis*, or *literalis*. See Algebra.

Calculus *differentialis* is a method of differencing quantities, that is, of finding an infinitely small quantity, which being taken an infinite number of times, shall be equal to a given quantity. An infinitely small quantity, or infinitesimal, is a portion of a quantity less than any assignable one; it is therefore accounted as nothing; and hence two quantities only differing by an infinitesimal, are reputed equal. The word infinitesimal is merely respective, and implies a relation to another quantity; for example, in astronomy, the diameter of the earth is an infinitesimal in respect of the distance of the fixed stars. Infinitesimals are likewise called differentials, or differential quantities, when they are considered as the differences of two quantities. Sir Isaac Newton calls them moments, considering them as momentary increments of quantities; for instance, of a line generated by the flux of a point, of a surface by the flux of a line, or of a solid by the flux of a surface. The calculus differentialis, therefore, and the doctrine of fluxions, are the same thing, un-

der different names, the latter given by Sir Isaac Newton, and the former by Mr. Leibnitz, who disputes with Sir Isaac the honour of the discovery. There is, however, one difference between them, which consists in the manner of expressing the differentials of quantities: Mr. Leibnitz, and most foreigners, express them by the same letters as variable ones, prefixing only the letter *d*: thus the differential of x is called dx, and the differential of y, dy: and dx is a positive quantity if x continually increase; and a negative quantity if x decrease. We, on the other hand, following Sir Isaac Newton, instead of dx, write $\dot{x}$, (with a dot over it), and instead of dy, $\dot{y}$, But foreigners reckon this method not so commodious as the former, because if differentials were to be differenced again, the dots would occasion great confusion; not to mention, that printers are more apt to overlook a point than a letter. See FLUXIONS.

CALCULUS *exponentialis*, among mathematicians, a method of differencing exponential quantities, and summing up the differentials of exponential quantities. By an exponential quantity is meant a power, the exponent of which is variable, as x^x, a^x. In order to difference an exponential quantity, nothing else is required than to reduce the exponential quantities to logarithmic ones, upon which the differencing is managed as in logarithmic ones.

By the same method may be found the differential of an exponential quantity of any power. This calculus was invented by Mr. John Bournoulli, and is used in investigating the properties of exponential curves.

CALCULUS *integralis* is a method of summing up differential quantities; that is, from a differential quantity given, to find the quantity from whose differencing the given differential results.

It is the inverse of the calculus differentialis; whence the English, who usually call the differential method fluxions, give this calculus, which ascends from the fluxions to the flowing quantities; or, as Wolfius and other foreigners express it, from the differences to the sums, the name of the inverse method of fluxions. See FLUXION.

CALEA, in botany, a genus of the Syngynesia Polygamia Æqualis. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate; down hairy or none; receptacle, chaffy. There are seven species, of which C. Jamaicensis has a shrubby stem, six or seven feet high; leaves hairy, rugged, three-nerved; flowers terminating, frequently three together; the pedicles of the same length with the flowers; calyx coloured; the pappus, or down, is rugged, and as long as the flower. Native of Jamaica, chiefly in the woods and inland parts of the island.

CALENDAR, a distribution of time, accommodated to the various uses of life, but more especially such as regard civil and ecclesiastical polity; in which sense it differs nothing from the modern almanacs.

The first calendar was made by Romulus, who divided the year into 10 months only, beginning on the first day of March, and containing 304 days, in which time he imagined the sun performed his course through all the seasons.

This calendar was reformed by Numa Pompilius, who added two months more, *viz.* January and February, placing them before March; his year began on the first of January, and consisted of 355 days. This was afterwards improved by Julius Cæsar, and was by him called the Julian account, which reduced the year to 365 days, 6 hours; and was retained in most protestant countries, and in our nation till the year 1752. This year is disposed into quadriennial periods, of which the three first years, which were called common, consisted of 365 days, and the fourth bissextile, of 366. See BISSEXTILE.

The Julian account was afterwards corrected by Pope Gregory XIII., which on that account obtained the name of the Gregorian calendar, or new style, the Julian being called the old style: and though the Gregorian calendar be preferable to the Julian, yet it is not without its defects: perhaps, as Tycho Brahe and Cassini imagine, it is impossible ever to bring the year to a perfect justness.

CALENDAR, *Julian Christian*, that wherein the days of the week are determined by the letters A, B, C, D, E, F, G, by means of the solar cycle; and the new and full moons, especially the paschal full moon, with the feast of Easter, and the other moveable feasts depending thereon, by means of golden numbers rightly disposed through the Julian year. See CYCLE, DOMINICAL LETTER, and GOLDEN NUMBER.

CALENDAR, *Gregorian*, that which, by means of epacts rightly disposed, through the several months, determines the new and full moons, and the time of Easter, with the moveable feasts depending thereon, in the Gregorian year. Therefore the Gregorian calendar differs from the Julian, both in the form of the year, and in that epacts

are substituted instead of golden numbers. See Epact.

Dr. Playfair, in his "System of Chronology," observes that the method of intercalation used in the Gregorian Calendar is not the most accurate. Ninety-seven days, or 100—3, are inserted in the space of four centuries. This supposes the tropical year to consist of $365^d, 5^h, 49', 12''$. On this supposition the interpolation would be exact, and the error would scarcely exceed one day in 268,000 years. But the reformers of the calendar made use of the Copernican year of $365^d, 5^h, 49', 20''$. Instead, therefore, of inserting 97 days in 400 years, they ought to have added, at proper intervals, 41 days in 169 years, or 90 days in 371 years, or 131 in 540 years, &c. Recent observations have determined the quantity of the tropical year to be $365^d, 5^h, 48' \, 45\frac{1}{2}''$. Admitting this to be the true quantity of it, the intercalations ought to be made as follows:

$$\overset{+}{\frac{4}{1}},\ \overset{-}{\frac{17}{4}},\ \overset{+}{\frac{33}{8}},\ \overset{-}{\frac{128}{31}},\ \overset{+}{\frac{545}{132}},\ \overset{+}{\frac{673}{163}},\ \overset{+}{\frac{801}{199}},\ \overset{+}{\frac{929}{225}},\ \overset{+}{\frac{1057}{256}},$$

$$\overset{+}{\frac{1185}{287}},\ \overset{+}{\frac{1313}{318}},\ \overset{-}{\frac{1441}{349}},\ \overset{-}{\frac{2754}{667}},\ \overset{-}{\frac{4067}{985}},\ \overset{+}{\frac{9447}{2288}},\ \overset{-}{\frac{51302}{12425}},$$

$\overset{+}{\frac{60749}{14713}},\ \overset{-}{\frac{172800}{41851}}$; that is, one day ought to be intercalated in the space of 4 years, or rather 4 days in 17 years, or 8 days in 33 years, &c. If 41,851 days were intercalated in 172,800 years there would be no error. The signs + and — indicate that the number of intercalary days above which they are placed is too great or too small. Every succeeding number is more accurate than that which goes before. As this method of interpolation is different from that now in use, it is obvious that the Gregorian calendar must be corrected after a certain period of years. The correction, however, will be inconsiderable for many ages, as it will amount only to a day and a half, which is to be suppressed in the space of 5000 years.

Calendar, *reformed or corrected*, that which, setting aside golden numbers, epacts, and dominical letters, determines the equinox, with the paschal full moon, and the moveable feasts depending thereon, by astronomical computations, according to the Rudolphine table. This calendar was introduced among the Protestant States of Germany in the year 1700, when 11 days were, at once, thrown out of the month of February, by which means the corrected style agrees with the Gregorian.

Calendar, *French*, *new*, is a quite new form of calendar that commenced in France on the 22d of September, 1792.

The year, in this calendar, commences at midnight the beginning of that day in which falls the true autumnal equinox for the observatory of Paris. The year is divided into 12 equal months, of 30 days each; after which 5 supplementary days are added, to complete the 365 days of the ordinary year: these 5 days do not belong to any month. Each month is divided into three decades of 10 days each; distinguished by 1st, 2d, and 3d decade. All these are named according to the order of the natural numbers, *viz.* the 1st, 2d, 3d, &c. month, or day of the decade, or of the supplementary days. The years which receive an intercalary day, when the position of the equinox requires it, which we call embolismic or bissextile, they call olympic; and the period of four years, ending with an olympic year, is called an olympiade; the intercalary day being placed after the ordinary five supplementary days, and making the last day of the olympic year. Each day, from midnight to midnight, is divided into 10 parts, each part into 10 others, and so on to the least measurable portion of time.

In this calendar too the months and days of them have new names. The first three months of the year, of which the autumn is composed, take their etymology; the first from the vintage, which takes place from September to October, and is called Vendemaire; the second, Brumaire, from the mists and low fogs, which show, as it were, the transudation of nature from October to November; the third, Frimaire, from the cold, sometimes dry and sometimes moist, which is felt from November to December. The three winter months take their etymology; the first, Nivose, from the snow which whitens the earth from December to January; the second, Pluviose, from the rains which usually fall in greater abundance from January to February; the third, Ventose, from the wind which dries the earth from February to March. The three spring months take their etymology; the first, Germinal, from the fermentation and developement of the sap from March to April; the second, Floreal, from the blowing of the flowers from April to May; the third, Prairial, from the smiling fecundity of the meadow crops from May to June.

Lastly, the three summer months take their etymology; the first, Messidor, from the appearance of the waving ears of corn and the golden harvests which cover the fields from June to July; the second, Thermidor, from the heat, at once solar and terrestrial, which inflames the air from July to August; the third, Fructidor, from the fruits gilt and ripened by the sun from August to September. Thus, the whole twelve months are;

AUTUMN.	SPRING.
Vendemaire	Germinal
Brumaire	Floreal
Frimaire.	Prairial.

WINTER.	SUMMER.
Nivose	Messidor
Pluviose	Thermidor
Ventose.	Fructidor.

From these denominations it follows, that by the mere pronunciation of the name of the month, every one readily perceives three things, and all their relations, *viz.* the kind of season, the temperature, and the state of vegetation: for instance, in the word Germinal, his imagination will easily conceive, by the termination of the word, that the spring commences; by the construction of the word, that the elementary agents are busied; and by the signification of the word, that the buds unfold themselves.

As to the names of the days of the week, or decade of 10 days each, which they have adopted instead of seven, as these bear the stamp of judicial astrology and heathen mythology, they are simply called from the first ten numbers: thus,

Primi	Sextidi
Duodi	Septidi
Tridi	Octidi
Quartidi	Nonidi
Quintidi	Decadi.

In the almanac, or annual calendar, instead of the multitude of saints, one for each day of the year, as in the Popish calendars, they annex to every day the name of some animal, or utensil, or work, or fruit, or flower, or vegetable, &c., appropriate and most proper to the times.

CALENDAR, *astronomical*, an instrument engraved upon copper-plates; printed on paper, and pasted on board, with a brass slider which carries a hair, and shows by inspection, the sun's meridian altitude, right ascension, declination, rising, setting, amplitude, &c. to a greater exactness than our common globes will shew.

CALENDAR *of prisoners*, a list of the names of the prisoners in the custody of the respective sheriffs of counties.

CALENDARIUM *floræ*, among botanists, a calendar, containing an exact register of the respective times, in which the plants of any given province, or climate, germinate, expand, and shed their leaves and flowers, and ripen and disperse seeds.

CALENDER, a machine used in manufactories, to press certain woollen and silken stuffs, and linens, to make them even, smooth, and glossy, or to give them waves, or water them, as may be seen in mohairs and tabbies. This instrument is composed of two thick cylinders, or rollers, of very hard and polished wood, round which the stuffs to be calendered are wound: these rollers are placed crossways between two very thick boards, the lower serving as a fixed base, and the upper moveable, by means of a thick screw, with a rope fastened to a spindle, which makes its axis: the uppermost board is loaded with large stones cemented together, weighing 20,000*lb.* or more. It is this weight that gives the polish, and makes the waves on the stuffs about the rollers, by means of a shallow indenture or engraving cut in it.

CALENDS, a Roman chronology, the first day of each month, so called from the Greek καλειν, to proclaim: it being customary on those days to proclaim the number of holy-days in each month. The calends were reckoned backwards, or in a retrograde order: thus, the first of May begins the calends of May; the 30th of April was the second of the calends of May; the 29th, the 3d, &c. to the 13th where the ides commence; which are also numbered in a retrograde order to the 5th, where the nones begin, and these are numbered after the same manner to the first of the month, which is the calends of April.

CALENDULA, in botany, the *marigold*, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ. Corymbiferæ, Jussieu: receptacle naked, flat; calyx many-leaved, nearly equal; seeds of the disk membranaceous. According to Martyn there are fourteen species, but Gmelin enumerates twenty-five. The flowers are commonly solitary and terminating. Many of the species are herbaceous and natives of the Cape of Good Hope. Of the garden mari-

gold there are the following varieties, *viz.* The single. The common double flowering. The largest very double flowering. The double lemon-coloured, and the greater and smaller childing marigold.

CALENTES, in logic, a sort of syllogism in the fourth, commonly called galenical, figure, wherein the major proposition is universal and affirmative; and the second or minor, as well as the conclusion, universal and negative.

This is intimated by the letters it is composed of, where the A signifies an universal affirmative, and the two E's as many universal negatives. *Ex. gr.*

CA. Every affliction in this world is only for a time.
lEn. No affliction, which is only for a time, ought to disturb us.
tEs. No affliction ought to disturb us, which happens in this world.

The Aristotelians, not allowing the fourth figure of syllogisms, turn this word into CElAntEs, and make it only an indirect mood of the first figure.

CALENTURE, in medicine, a feverish disorder incident to sailors in hot climates; the principal symptom of which is, their imagining the sea to be green fields: hence, attempting to walk abroad in these imaginary places of delight, they are frequently lost.

CALIBER, or CALIPER, properly denotes the diameter of any body: thus we say, two columns of the same caliber, the caliber of the bore of a gun, the caliber of a bullet, &c.

CALIBER *compasses*, the name of an instrument, made either of wood, iron, steel, or brass; that used for measuring bullets consists of two branches bending inwards, with a tongue fixed to one of them, and the other graduated in such a manner, that if the bullet be compressed by the ends of the two branches, and the tongue be applied to the graduated branch, it will shew the weight of the bullet.

On these rulers are a variety of scales, tables, proportions, &c. which are reckoned very useful to gunners. On the best caliber compasses we have the measure of convex and concave diameters in inches. 2. The weight of iron shot from given diameters. 3. The weight of iron shot from given gun bores. 4. The degrees of a semi-circle. 5. The proportion of troy and avoirdupois weight. 6. The proportion of English and French feet and pounds. 7. Factors used in circular and spherical figures. 8. Tables of the specific gravities and weights of bodies. 9. Tables of the quantity of powder necessary for proof and service of brass and iron guns. 10. Rules for computing the number of shot or shells in a finished pile. 11. Rules concerning the fall of heavy bodies. 12. Rules for raising water and for firing artillery and mortars. 13. A line of inches. 14. Logarithmic scales of numbers, sines, versed sines, and tangents. 15. A sectoral line of equal parts, or the line of lines. 16. A sectoral line of planes and superficies. 17. A sectoral line of solids.

CALIBER also signifies an instrument used by carpenters, joiners, and bricklayers, to see whether their work be well squared.

CALICO, a species of cloth of cotton thread, manufactured formerly in the East Indies; but now we have in this country established manufactories which equal those in the East. It is said that in this business, and in the printing of calicoes, there are 150,000 persons employed. Cotton, in its raw state, is imported into this country, but calicoes are prohibited under the severest penalties.

CALICO-*printing*: the art of cloth-printing or calico-printing, in other words, of dying in certain colours particular spots of the cloth, or figures impressed on it, while the ground shall be of a different colour or entirely white, affords perhaps the most direct and obvious illustration of the application of these principles. The mordant which is principally used in this process is the acetate of argil. It is prepared by dissolving *3lbs.* of alum and *1lb.* of acetate of lead in *8lbs.* of warm water. An exchange of the principles of these salts takes place: the sulphuric acid of the alum combines with the oxide of lead, and the compound thus formed being insoluble is precipitated, the acetic acid remains united with the argil of the alum in solution. There are added at the same time two ounces of the potash of commerce, and two ounces of chalk; the principal use of which appears to be, to neutralize the excess of acid that might act on the colouring matter and alter its shade.

The superiority of this acetate of argil as a mordant to the cheaper sulphate of argil or alum, arises principally from two circumstances,—from the affinity between its principles being weaker, in consequence of which the argil more easily separates from the acid, and unites with the cloth and the

colouring matter: and 2dly, from the acetic acid disengaged in the process, not acting with the same force on the colouring matter as the sulphuric acid would do. The acetate being also very soluble, and having little tendency to crystallize, can be more equally mixed and applied. The discovery of this mordant, so essential in the art of calico-printing, was altogether accidental, or rather empirical. The recipes of the calico-printers were at one time very complicated: different articles were from time to time omitted or changed, until at length the simple mixture of alum and acetate of lead was found to answer as a mordant, equally with compositions more complicated; and even after its discovery, its operation for a time was far from being understood by the artist. The mordant thus prepared is thickened with gum or starch; or in this country, within these few years, with the mucilage prepared from lichens scalded and boiled with a little potash. It is applied by wooden blocks, or stamps to the parts of the cloth on which the figures cut in the stamp are designed to be impressed, or by a pencil if more delicate lines are to be traced. The cloth is afterwards dried thoroughly, is washed in warm water to remove the mucilage and the superfluous mordant, and is then dipped in the dye colour, suppose it to be an infusion of madder; the whole is dyed, but the parts which have been impregnated with the mordant, receive a brighter colour than the part which has not: the colour too of the former is permanent, while that of the latter is fugitive. It is discharged by subsequent boiling with substances having a weak attraction to the colouring matter, principally with bran, and by exposure on the field, repeating these alternately. The ground of the cloth is thus at length rendered white, while the colours of the parts on which the mordant has been impressed, representing of course the design on the stamp, remain with little or no alteration.

Sometimes after the whole cloth has been permanently dyed, by having been impregnated with the mordant, the colour is discharged from certain parts, by stamping these with a weak acid liquor: after being washed, these are again stamped, either with the same or with a different mordant, and dyed with different materials; and thus the most difficult kind of cloth printing is effected, where the ground is coloured, and at the same time impressed with a design in different colours. By combining these methods too, and by dextrously applying to different parts of the cloth different mordants, by stamps adapted to each other, so as to form a regular design, different colours are impressed either on a white or coloured ground.

CALK, a genus of minerals, which is divided into twenty species. 1. Rock-milk, denominated by Werner, bergmilch. 2. Chalk, denominated kreide, or creta alba: external characters; colour white; occurs massive disseminated, and as a crust covering flint; fragments indeterminately angular, blunt edged; opaque; soils; writes; easily frangible; specific gravity according to Kirwan 2.3, but bishop Watson takes it at 2.6; various specimens will no doubt account for this and other differences of the same kind. It effervesces strongly with acids, and is found to consist almost entirely of lime and carbonic acid. It constitutes a peculiar kind of formation; contains numerous flinty petrefactions; and is even remarkable for being the most general repository of flint. It is found chiefly on sea-coasts, as at Calais and Dover, and several of the Danish islands in the Baltic, as Rugen and Zealand: it occurs also in Poland, and several great tracts of country in the south of England are composed of it. In some parts of Kent a chalk pit is no contemptible estate, producing from one to five hundred per annum and upwards. In the manufactures it is used for polishing and cleansing metals, glass, &c. and when burnt into lime it is of great importance in building. 3. Lime-stone; denominated kalkstein, which is divided into four sub-species, *viz.* compact-limestone; foliated limestone; fibrous limestone; peastone. The first is of a greyish colour, composed chiefly of lime and carbonic acid, with small portions of iron, alumina, and inflammable matter; and is found in the sandstone and coal formations of Saxony, Bohemia, Bavaria, Sweden, France, England, Scotland, &c. It is used as mortar, when deprived of its carbonic acid, and in this state also it is employed in the manufacture of soap, in tanning, and other processes. It is likewise used as a flux, in the reduction of such ores as are difficultly fusible, by means of its silica and alumina. The Florentine arborescent marble, a variety of this species, is, according to Jameson, very valuable for the purposes of ornament; and the limestone of Pappenheim serves for paving, grave-stones, and sometimes for polishing plate-glass. Of the

foliated limestone, the granular is the most important variety: this is purer than common limestone, is found peculiarly beautiful at Carrava in Italy, where it is quarried, and from thence distributed over Europe, for the purposes of statuary. The white marble of Paros has been long celebrated for its fitness for sculpture, and other useful purposes. Calc-spar is another variety, of which many of its most beautiful and rare crystallizations are found in Derbyshire, in Ireland, and many parts of the continent. The fibrous limestone occurs only in small veins: the satin spar of Derbyshire belongs to this kind. The calc-sinter is a variety of the fibrous limestone, of which there is a striking instance in the grotto of Antepa-ros: when it occurs in large masses, it is used by the statuary for many of the purposes of marble. The alabaster of the ancients is calc-sinter. It was brought from Arabia in considerable quantities, and used principally for the drapery of marble statues. Peastone is found in great masses in the vicinity of the hot springs at Carlsbad in Bohemia. Particles of sand appear to be raised in the water by means of air-bubbles, and become covered with calcareous earth, which is deposited around them in lamellar concretions of the size of a pea, hence the name. 4. Schaum earth, or foaming earth, found in the neighbourhood of Gera, in the forest of Thuringia; also in the north of Ireland: it is called by Werner Schaumerde, and is thought by him to be nearly allied to slate spar, which is another species, composed almost entirely of carbonate of lime. The remaining species we pass over as of less interest.

CALKING, any kind of military drawing upon paper, &c. It is performed by covering the backside of the drawing with a black or red colour, and fixing the side so covered upon a piece of paper, waxed plate, &c. This being done, every line in the drawing is to be traced over with a point, by which means all the outlines will be transferred to the paper or plate, &c.

CALL, among fowlers, means the noise or cry of a bird, especially to its young, or its mate in coupling time.

The call of a bird, says the honourable Daines Barrington, is that sound which it is able to make when about a month old: it is, he says, in most instances, a repetition of one and the same note, is retained by the bird as long as it lives, and is common, generally, both to the cock and hen. One method of catching partridges, is by the natural call of a hen trained for the purpose, which drawing the cocks to her, gives opportunity for entangling them in a net.

Calls are also a sort of artificial pipes, made to catch several sorts of birds, by imitating their notes. Different birds require different sorts of artificial calls; but they are most of them composed of a pipe or reed, with a little leathen bag or purse, somewhat in form of a bellows, which, by the motion given thereto, yields a noise like that of the species of bird to be taken. The call for patridges is formed like a boat, bored through, and fitted with a pipe, or swan's quill, &c. to be blown with the mouth, to make the noise of the cock partridge, which is very different from the call of the hen. Calls for quails, &c. are made of a leathern purse in shape like a pear, stuffed with horse hair, and fitted at the end with the bone of a cat's, hare's, or coney's leg, formed like a flageolet: they are played by squeezing the purse in the palm of the hand, at the same time striking on the flageolet part with the thumb to counterfeit the call of the hen quail.

Call, in sea-language, a sort of whistle or pipe, of silver or brass, used by the boatswain and his mates to summon the sailors to their duty, and direct them in their several employments. It is sounded to various strains, adapted to the different exercises, as hoisting, heaving, &c. and the piping of it serves the same purposes among sailors, as the beat of the drum among soldiers.

Call *of the house*, in a parliamentary sense, has been sometimes practised, to discover whether there be any in the house not returned by the clerk of the crown; but more frequently to discover what members are absent without leave of the house, or just cause. In the former case, the names of the members being called over, every person answers to his name, and departs out of the house, in the order wherein he is called. In the latter, each person stands up uncovered, at the mention of his name.

CALLA, in botany, a genus of the Gynandria Polyandria class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spathe flat; spadix covered with floscules; calyx and petals none; berries many-seeded. There are four species, of which C. æthiopica, Ethiopian calla, is a plant which grows naturally at the Cape, but has long been an inhabitant in the English gardens.

CALLICARPA, in botany, a genus of the Tetrandria Monogynia class and order.

Natural order of Dumosæ. Vitices, Jussieu. Essential character: calyx four-cleft; corolla four-cleft; berry four-seeded. There are seven species, of which C. Americana, American callicarpa, is a shrub from four to six feet in height; calyx cylindric; corolla funnel-form; germ superior. Native of North America; also of Cochinchina, which shows the impropriety of the trivial name.

CALLIGONUM, in botany, a genus of the Dodecandria Tetragynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx five-parted; corolla none; filaments about sixteen, slightly united at the base; germ superior, four-sided; nut one-celled, with a crust that has several wings, or many bristles. There are three species. The first is a native of America, the second of Egypt and Barbary, and the third of Cochinchina.

CALLIONYMUS, in natural history, dragonet, a genus of fishes of the order Jugulares. Generic character: eyes vertical, approximated; gill-covers shut, with a small aperture on each side the neck; gill-membrane six-rayed; body naked; ventral fins very remote. There are seven species, of which we shall notice, C. lyra, or gemmeous dragonet, so called from the peculiar form of its first dorsal fin, the shape of which bears a fancied resemblance to that of an ancient lyre or harp. It is a native of the Mediterranean and Northern Seas, and measures about 12 inches in length. Like most other fishes, the dragonet varies slightly in colour in different individuals, and at different seasons of the year. Mr. Pennant describes the pupils of the eyes to be of a rich sapphirine blue; the irides fine fiery carbuncle; the pectoral fins light brown; the side-line straight; the colours of the fish yellow, blue, and white, making a beautiful appearance when fresh taken. The blue is of inexpressible splendor; the richest cærulean, glowing with a gemmeous brilliancy; the throat black. C. dracunculus, or sordid dragonet, is nearly allied to the preceding; a native of the Mediterranean and Northern Seas; both are numbered with the edible fishes, and are supposed to live principally on worms and sea-insects.

CALLISIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: calyx three-leaved; petals three; anthers double; capsule two-celled. There is but one species, *viz.* C. repens, creeping callisia. It is a native of the West Indies, in low, moist, shady places. Here it flowers in June and July.

CALLITRICHE, in botany, a genus of the Monandria Digynia. Natural order of Holoraceæ. Naiades, Jussieu. Essential character: calyx none; petals two; capsule two-celled, four-seeded. There are two species, *viz.* C. verna, vernal star-wort, or star-headed water-chickweed, and C. autumnalis, autumnal star-wort. These are very common in ditches and standing water, and is sometimes so thickly matted together, that one may walk upon it without sinking.

CALLUS, or CALLOSITY, in a general sense, any cutaneous, corneous, or osseous hardness, whether natural or preternatural: but most frequently it means the callus generated about the edges of a fracture, provided by nature to preserve the fractured bones, or divided parts, in the situation in which they are replaced by the surgeon.

CALM, in sea-language, is when there is no wind stirring.

That tract of sea, to the northward of the equator, between 4° and 10° of latitude, lying between the meridians of Cape Verde, and of the easternmost island of that name, seems to be a place condemned to perpetual calms: the winds that do exist being only some sudden uncertain gusts of very small continuance, and less extent. The Atlantic Ocean, near the equator, is very much subject, nay always attended with these calms.

A long calm is often more fatal to a ship than the severest tempest, for if tight and in good condition, she may sustain the latter without much injury, whereas in a long calm, the provision and water may be entirely consumed, without any opportunity of obtaining a fresh supply. Calms are never so great on the ocean as on the Mediterranean, because the flowing and ebbing of the former keep the water in continual agitation, even where there is no wind; whereas there being no tides in the latter, the calm is sometimes so dead, that the surface of the water is as clear as a looking-glass; but such calms are generally the presages of an approaching storm. On the coast about Smyrna, a long calm is said to be prognostic of an earthquake.

CALODENDRUM, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla spreading, five-

petalled; nectary five-leaved; capsule five-celled. There is but one species, *viz.* C. capense, which is an evergreen. Flowers in terminating panicles, or opposite one flowered peduncles. Native of the Cape.

CALOMEL, in the materia medica, a name given to mercurius dulcis. See MERCURY.

CALOPHYLLUM, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx four-leaved, coloured; corolla four-petalled; drupe globular. There are two species; *viz.* C. inophyllum and C. calaba, both natives of the East and West Indies. They are both lofty trees, ninety feet in height, and twelve in thickness: leaves like those of the water lily. In Java they plant these trees about their houses, for the elegance of the shade and the sweetness of the flowers.

CALOPUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform; four feelers, the fore ones clavate, the hind ones filiform; thorax gibbous; shells linear. There are three species; *viz.* the serraticornis, hispicornis, and pygmæus.

CALORIC, in chemistry, a word used to signify that substance or property by which the phenomena of heat are produced. Concerning the nature of caloric there are two opinions, which have divided philosophers ever since they turned their attention to the subject. Some suppose that caloric, like gravity, is merely a property of matter, and that it consists in a peculiar vibration of its particles; others, on the contrary, think that it is a distinct substance. Each of these opinions has been supported by the greatest philosophers; and till lately the obscurity of the subject has been such, that both sides have been able to produce exceedingly plausible and forcible arguments. The recent improvements, however, in this branch of chemistry have gradually rendered the latter opinion much more probable than the former: and a recent discovery, made by Dr. Herschel, has at last nearly put an end to the dispute, by demonstrating that caloric is not a property, but a peculiar substance; or at least, that we have the same reason for considering it to be a substance as we have for believing that light is material. Dr. Herschel had been employed in making observations on the sun, by means of telescopes. To prevent the inconvenience arising from the heat, he used coloured glasses; but these glasses, when they were deep enough coloured to intercept the light, very soon cracked, and broke in pieces. This circumstance induced him to examine the heating power of the different coloured rays. He made each of them in its turn fall upon the bulb of a thermometer, near which two other thermometers were placed to serve as a standard. The number of degrees which the thermometer exposed to the coloured ray rose above the other two thermometers indicated the heating power of that ray. He found that the most refrangible rays have the least heating power, and that the heating power gradually increases as the refrangibility diminishes. The violet ray therefore has the smallest heating power, and the red ray the greatest. Dr. Herschel found, that the heating power of the violet, green, and red rays, are to each other as the following numbers:

Violet........ = 16.
Green........ = 22.4
Red........... = 55.

It struck Dr. Herschel as remarkable, that the illuminating power and the heating power of the rays follow such different laws. The first exists in greatest perfection in the middle of the spectrum, and diminishes as we approach either extremity; but the second increases constantly from the violet end, and is greatest at the red end. This led him to suspect that perhaps the heating power does not stop at the end of the visible spectrum, but is continued beyond it. He placed the thermometer completely beyond the boundary of the red ray, but still in the line of the spectrum, and it rose still higher than it had done when exposed to the red ray. On shifting the thermometer still farther it continued to rise, and the rise did not reach its maximum till the thermometer was half an inch beyond the utmost extremity of the red ray. When shifted still farther, it sunk a little; but the power of heating was sensible at the distance of $1\frac{1}{2}$ inch from the red ray. These important experiments have been lately repeated and fully confirmed by Sir Henry Englefield, in the presence of some very good judges.

From these it follows, that there are rays emitted from the sun which produce heat, but have not the power of illuminating; and that these are the rays which produce the greatest quantity of heat. Consequently caloric is emitted from the sun in rays, and the rays of caloric are not the same with the rays of light. On examining the other extremity of the spectrum, Dr. Herschel ascertained that no rays of caloric can be

traced beyond the violet ray. He had found, however, that all the coloured rays of the spectrum have the power of heating: it may be questioned, therefore, whether there be any rays which do not warm. The coloured rays must either have the property of exciting heat as rays of light, or they must derive that property from a mixture of rays of caloric. If the first of these suppositions were true, light ought to excite heat in all cases; but it has been long known to philosophers, that the light of the moon does not produce the least sensible heat, even when concentrated so strongly as to surpass in point of illumination the brightest candles or lamps, and yet these produce a very sensible heat. Here then are rays of light which do not produce heat: rays, too, composed of all the seven prismatic coloured rays. We must conclude from this well-known fact, that rays of light do not excite heat; and consequently that the coloured rays from the sun and combustible bodies, since they excite heat, must consist of a mixture of rays of light and rays of caloric. That this is the case was demonstrated long ago by Dr. Hooke, and afterwards by Scheele, who separated the two species from each other by a very simple method. If a glass mirror be held before a fire, it reflects the rays of light, but not the rays of caloric; a metallic mirror, on the other hand, reflects both. The glass mirror becomes hot; the metallic mirror does not alter its temperature. If a plate of glass be suddenly interposed between a glowing fire and the face, it intercepts completely the warming power of the fire, without causing any sensible diminution of its brilliancy; consequently it intercepts the rays of caloric, but allows the rays of light to pass. If the glass be allowed to remain in its station till its temperature has reached its maximum, in that situation it ceases to intercept the rays of caloric, but allows them to pass as freely as the rays of light. This curious fact, which shews us that glass only intercepts the rays of caloric till it be saturated with them, was discovered by Dr. Robison. These facts are sufficient to convince us, that the rays of light and of caloric are different, and that the coloured rays derive their heating power from the rays of caloric which they contain. Thus it appears that solar light is composed of three sets of rays, the colorific, the calorific, and the deoxidizing. The rays of caloric are refracted by transparent bodies just as the rays of light. We see too, that, like the rays of light, they differ in their refrangibility; that some of them are as refrangible as the violet rays; but that the greater number of them are less refrangible than the red rays. Whether they are transmitted through all transparent bodies has not been ascertained; neither has the difference of their refraction in different mediums been examined. We are certain, however, that they are transmitted and refracted by all transparent bodies which have been employed as burning-glasses. Dr. Herschel has also proved, by experiment, that it is not only the caloric emitted by the sun which is refrangible; but likewise the rays emitted by common fires, by candles, by hot iron, and even by hot water. The rays of caloric are reflected by polished surfaces in the same manner as the rays of light. This was lately proved by Herschel; but it had been demonstrated long before by Scheele, who had even ascertained that the angle of their reflection is equal to the angle of their incidence. M. Pictet also had made a set of very ingenious experiments on this subject, about the year 1790, which led to the same conclusion.

All the phenomena concur to shew, that the rays of caloric move with a very considerable velocity, though the rate has not been ascertained in a satisfactory manner. Some experiments of Mr. Leslie would lead us to conclude, that they move with the same velocity as sound. The following experiment of M. Pictet indicates a very considerable velocity. He placed two concave mirrors at the distance of 69 feet from each other; the one of tin, the other of plaster gilt, and 18 inches in diameter. Into the focus of this last mirror he put an air thermometer, and a hot bullet of iron into that of the other. A few inches from the face of the tin mirror there was placed a thick screen, which was removed as soon as the bullet reached the focus. The thermometer rose the instant the screen was removed without any perceptible interval, consequently the time which caloric takes in moving 69 feet is too minute to be measured. The velocity of caloric, if it is equal to that of light, would prove that its particles must be equally minute. Therefore, neither the addition of caloric nor its abstraction can sensibly affect the weight of bodies.

Caloric agrees with light in another property no less peculiar: its particles are never found cohering together in masses; and whenever they are forcibly accumulated, they fly off in all directions, and se-

parate from each other with inconceivable rapidity. This property necessarily supposes the existence of a mutual repulsion between the particles of caloric. Thus it appears that caloric and light resemble each other in a great number of properties. Both are emitted from the sun in rays, with the velocity of 200,000 miles in a second; both of them are refracted by transparent bodies, and reflected by polished surfaces; both of them consist of particles which mutually repel each other, and which produced no sensible effect upon the weight of other bodies. They differ, however, in this particular: light produces in us the sensation of vision; caloric, on the contrary, the sensation of heat. Upon the whole, we are anthorized by the above statement of facts, to conclude, that the solar light is composed of three distinct substances, in some measure separable by the prism, on account of the difference of their refrangibility. The calorific rays are the least refrangible, the deoxidizing rays are most refrangible, and the colorific rays possess a mean degree of refrangibility. Hence the rays in the middle of the spectrum have the greatest illuminating power; those beyond the red end the greatest heating power, and those beyond the violet end the greatest deoxidizing power: and the heating power on the one hand, and the deoxidizing power on the other, gradually increase as we approach that end of the spectrum where the maximum of each is concentrated. These different bodies resemble each other in so many particulars, that the same reasoning respecting refrangibility, reflexibility, &c. may be applied to all; but they produce different effects upon those bodies on which they act. Little progress has yet been made in the investigation of these effects; but we may look forward to this subject as likely to correct many vague and unmeaning opinions, which are at present in vogue among chemists.

From this account of the nature of caloric, we learn that it is capable, like light, of radiating in all directions from the surfaces of bodies; and that when thus radiated, it moves with a very considerable velocity. Like light, too, it is liable to be absorbed when it impinges against the surfaces of bodies. When it has thus entered, it is capable of making its way through all bodies; but its motion in this case is comparatively slow. Heat then moves at two very different rates. 1. It escapes from the surfaces of bodies. 2. It is conducted, or passes through bodies.

When bodies artificially heated are exposed to the open air, they immediately begin to emit heat, and continue to do so till they become nearly of the temperature of the surrounding atmosphere. That different substances when placed in this situation, cool down with very different degrees of rapidity, could not have escaped the most careless observer; but the influence of the surface of the hot body in accelerating or retarding the cooling process, was not suspected till lately. For this curious and important part of the doctrine of heat, we are indebted to the sagacity of Mr. Leslie, who has already brought it to a great degree of perfection. To whose work we refer the philosophical reader, for much useful and highly interesting matter.

Although caloric is incapable of moving in rays through solid bodies; yet it is well known that all bodies whatever are pervious to it. Through solids, then, it must pass in a different manner. In general its passage through them is remarkably slow. Thus if we put the end of a bar of iron, 20 inches long, into a common fire, while a thermometer is attached to the other extremity; four minutes elapse before the thermometer begins to ascend, and 15 minutes by the time it has risen 15°. In this case, the caloric takes four minutes to pass through a bar of iron 20 inches in length. When caloric passes in this slow manner, it is said to be conducted through bodies. It is in this manner alone that it passes through non-elastic bodies; and though it often moves by radiation through elastic media, yet we shall find that it is capable of being conducted through them likewise. As the velocity of caloric, when it is conducted through bodies is greatly retarded, it is clear that it does not move through them without restraint. It must be detained for some time by the particles of the conducting body, and consequently must be attracted by them. Hence it follows, that there is an affinity or attraction between caloric and every conductor. It is in consequence of this affinity that it is conducted through the body.

Bodies then conduct caloric in consequence of their affinity for it, and the property which they have of combining indefinitely with additional doses of it. Hence the reason of the slowness of the process, or, which is the same thing, of the long time necessary to heat or to cool a body. The

process consists in an almost infinite number of repeated compositions and decompositions. We see, too, that when heat is applied to one extremity of a body, the temperature of the strata of that body must diminish equably, according to their distance from the source of heat. Every person must have observed that this is always the case. If, for instance, we pass our hand along an iron rod, one end of which is held in the fire, we shall perceive its temperature gradually diminishing from the end in the fire, which is hottest, to the other extremity, which is coldest. Hence the measure of the heat transmitted, must always be proportional to the excess of temperature communicated to that side of the conductor which is nearest the source of heat. The passage of caloric through a body by its conducting power must have a limit; and that limit depends upon the number of doses of caloric, with which the stratum of the body nearest the source of heat is capable of combining. If the length of a body be so great, that the strata of which it is composed exceed the number of doses of caloric with which a stratum is capable of combining, it is clear that caloric cannot possibly be conducted through the body; that is to say, the strata farthest distant from the source of heat cannot receive any increase of temperature. This limit depends, in all cases, upon the quantity of caloric with which a body is capable of combining before it changes its state. All bodies, as far as we know at present, are capable of combining indefinitely with caloric; but the greater number, after the addition of a certain number of doses, change their state. Thus ice, after combining with a certain quantity of caloric, is changed into water, which is converted in its turn to steam, by the addition of more caloric. Metals also, when heated to a certain degree, melt, are volatilized, and oxydated: wood and most other combustibles catch fire, and are dissipated. As to the rate at which bodies conduct caloric, that depends upon the specific nature of each particular body; the best conductors conducting most rapidly, and to the greatest distance. When bodies are arranged into sets, we may lay it down as a general rule, that the densest set conduct at the greatest rate. Thus the metals conduct at a greater rate than any other bodies. But in considering the individuals of a set, it is not always the densest that conducts best: as bodies conduct caloric in consequence of their affinity for it, and as all bodies have an affinity for caloric, it follows as a consequence, that all bodies must be conductors, unless their conducting power be counteracted by some other property.

All solids are conductors; because all solids are capable of combining with various doses of caloric before they change their state. This is the case in a very remarkable degree with all earthy and stony bodies; it is the case also with metals, with vegetables, and with animal matters. This, however, must be understood with certain limitations. All bodies are indeed conductors; but they are not conductors in all situations. Most solids are conductors at the common temperature of the atmosphere; but when heated to the temperature at which they change their state, they are no longer conductors. Thus at the temperature of 60°, sulphur is a conductor; but when heated to 214°, or the point at which it melts or is volatilized, it is no longer a conductor. In the same manner ice conducts caloric when at the temperature of 20°, or any other degree below the freezing point; but ice at 32° is not a conductor, because the addition of caloric causes it to change its state.

With respect to liquids and gaseous bodies, it would appear at first sight that they also are all conductors; for they can be heated as well as solids, and heated too considerably without sensibly changing their state. But fluids differ from solids in one essential particular: their particles are at full liberty to move among themselves, and they obey the smallest impulse; while the particles of solids, from the very nature of these bodies, are fixed and stationary. One of the changes which caloric produces on bodies is expansion, or increase of bulk; and this increase is attended with a proportional diminution of specific gravity. Therefore, whenever caloric combines with a stratum of particles, the whole stratum becomes specifically lighter than the other particles. This produces no change of situation in solids; but in fluids, if the heated stratum happens to be below the other strata, it is pressed upwards by them, and being at liberty to move, it changes its place, and is buoyed up to the surface of the fluid. In fluids, then, it makes a very great difference to what part of the body the source of heat is applied. If it be applied to the highest stratum of all, or to the surface of the liquid, the caloric can only make its way downwards, as through solids, by the conducting power of the fluid; but if it be applied to the lowest

stratum, it makes its way upwards, independently of that conducting power, in consequence of the fluidity of the body, and the expansion of the heated particles. The lowest stratum, as soon as it combines with a dose of caloric, becomes specifically lighter, and ascends. New particles approach the source of heat, combine with caloric in their turn, and are displaced. In this manner all the particles come, one after another, to the source of heat; of course the whole of them are heated in a very short time, and the caloric is carried almost at once to much greater distances in fluids than in any solid whatever. Fluids, therefore, have the property of carrying or transporting caloric; in consequence of which they acquire heat independently altogether of any conducting power.

If we take a bar of iron and a piece of stone of equal dimensions, and putting one end of each into the fire, apply either thermometers or our hands to the other, we shall find the extremity of the iron sensibly hot long before that of the stone. Caloric, therefore, is not conducted through all bodies with the same celerity and ease. Those that allow it to pass with facility, are called good conductors; those through which it passes with difficulty, are called bad conductors.

Metals are the best conductors of caloric of all the solids hitherto tried. The conducting powers of all, however, are not equal. Dr. Ingenhousz procured cylinders of several metals exactly of the same size, and having coated them with wax, he plunged their ends into hot water, and judged of the conducting power of each by the length of wax-coating melted. From these experiments he concluded, that the conducting power of the metals which he examined were in the following order:

Silver,
Gold,
Copper, } nearly equal.
Tin,
Platinum, }
Iron, } much inferior to the others.
Steel,
Lead,

Next to metals, stones seem to be the best conductors; but this property varies considerably in different stones. Bricks are much worse conductors than most stones.

Glass seems not to differ much from stones in its conducting power: like them, it is a bad conductor. This is the reason that it is so apt to crack on being suddenly heated or cooled. One part of it, receiving or parting with its caloric before the rest, expands or contracts, and destroys the cohesion. Next to these, some dried woods.

Charcoal is also a bad conductor: according to the experiments of Morveau, its conducting power is to that of fine sand :: 2 : 3. Feathers, silk, wool, and hair are still worse conductors than any of the substances yet mentioned. This is the reason that they answer well for articles of clothing. They do not allow the heat of the body to be carried off by the cold external air. Count Rumford has made a very ingenious set of experiments on the conducting power of these substances. He ascertained that their conducting power is inversely as the fineness of their texture.

Having in the preceding sections considered the nature of caloric, the manner in which it moves through other bodies and distributes itself among them; let us now examine, in the next place, the effects which it produces on other bodies, either by entering into them or separating from them. The effects which caloric produces on bodies, may be arranged under three heads; namely, changes in bulk; changes in state; and changes in combination.

It may be laid down as a general rule, to which there is no known exception, that every addition or abstraction of caloric makes a corresponding change in the bulk of the body which has been subjected to this alteration in the quantity of its heat.

In general the addition of heat increases the bulk of a body, and the abstraction of it diminishes its bulk; but this is not uniformly the case, though the exceptions are not numerous.

Indeed these exceptions are not only confined to a very small number of bodies, but even in them they do not hold, except at certain particular temperatures; while at all other temperatures these bodies are increased in bulk when heated, and diminished in bulk by being cooled. We may therefore consider expansion as one of the most general effects of heat. It is certainly one of the most important, as it has furnished us with the means of measuring all the others. See PYROMETER.

Though all bodies are expanded by heat, and contracted by cold, and this expansion in the same body is always proportional to some function of the quantity of caloric added or abstracted; yet the absolute expansion or contraction has been found to differ exceedingly in different bodies. In general, the expansion of gaseous bodies is greatest of

all; that of liquids is much smaller; and that of solids the smallest of all. Thus, 100 cubic inches of atmospheric air, by being heated from the temperature of 32° to that of 212°, are increased to 137.5 cubic inches: while the same augmentation of temperature only makes 100 cubic inches of water assume the bulk of 104.5 cubic inches: and 100 cubic inches of iron, when heated from 32° to 212°, assume a bulk scarcely exceeding 100.1 cubic inches. From this example, we see that the expansion of air is more than eight times greater than that of water; and the expansion of water about 45 times greater than that of iron. See EXPANSION.

All substances in nature, as far as we are acquainted with them, occur in one or other of the three following states; namely, the state of solids, of liquids, or of elastic fluids or vapours. It has been ascertained, that in a vast number of cases, the same substance is capable of existing successively in each of these states. All solid bodies, a very small number excepted, may be converted into liquids by heating them sufficiently; and, on the other hand, every liquid, except spirit of wine, is convertible into a solid body, by exposing it to a sufficient degree of cold. All liquid bodies may, by heating them, be converted into elastic fluids, and a great many solids are capable of undergoing the same change; and lastly, the number of elastic fluids which by cold are condensible into liquids or solids, is by no means inconsiderable. These facts have led philosophers to form this general conclusion, "that all bodies, if placed in a temperature sufficiently low, would assume a solid form; that all solids become liquids when sufficiently heated; and that all liquids, when exposed to a certain temperature, assume the form of elastic fluids." The state of bodies then depends upon the temperature in which they are placed; in the lowest temperatures they are all solid; in higher temperatures they are converted into liquids; and in the highest of all they become elastic fluids. The particular temperatures at which bodies undergo those changes are exceedingly various, but they are always constant for the same bodies. Thus we see that heat produces changes on the state of bodies, converting them all, first into liquids, and then into elastic fluids.

When solid bodies are converted by heat into liquids, the change in some cases takes place at once. There is no interval between solidity and liquidity; but in other cases a very gradual change may be perceived; the solid becomes first soft, and it passes through all the degrees of softness, till at last it becomes perfectly fluid. The conversion of ice into water is an instance of the first change; for in that substance there is no intervening state between solidity and fluidity. The melting of glass, of wax, and of tallow, exhibits instances of the second kind of change; for these bodies pass through every degree of softness before they terminate in perfect fluidity. In general, those solid bodies which crystallize or assume regular prismatic figures, have no interval between solidity and fluidity; while those that do not usually assume such shapes, have the property of appearing successively in all the intermediate states.

Caloric not only increases the bulk of bodies, and changes their state from solids to liquids, and from liquids to elastic fluids; but its action decomposes a great number of bodies altogether, either into their elements, or it causes these elements to combine in a different manner. Thus when ammonia is heated to redness, it is resolved into azotic and hydrogen gases. Alcohol, by the same heat, is converted into carburated hydrogen and water.

This decomposition is in many cases owing to the difference between the volatility of the ingredients of a compound. Thus, when weak spirits, or a combination of alcohol and water, are heated, the alcohol separates, because it is more volatile than the water. In general, the compounds which are but little or not at all affected by heat, are those bodies which have been formed by combustion. Thus water is not decomposed by any heat which can be applied to it; neither are sulphuric, phosphoric, or carbonic acids. Almost all the combinations into which oxygen enters without having occasioned combustion, are decomposable by heat. This is the case with nitric acid, hyperoxymuriatic acid, and many of the metallic oxides.

All bodies that contain combustibles as component parts are decomposed by heat. Perhaps the metallic alloys are exceptions to this rule; at least it is not in our power to apply a temperature high enough to produce their decomposition, except in a few cases.

When two combustible ingredients and likewise oxygen occur together in bodies, they are always very easily decomposed by heat. This is the case with the greater number of animal and vegetable substances.

Having examined the nature, and some

few of the properties, and effects of caloric, as far as the subject has been hitherto investigated, it now only remains for us to mention the different methods by which caloric may be evolved or made sensible, or the different sources from which it may be obtained. These sources may be reduced to five: it radiates constantly from the sun; it is evolved during combustion; and it is extricated in many cases by percussion, friction, and mixture. The sources of heat, then, are the SUN, COMBUSTION, PERCUSSION, FRICTION, MIXTURE, which see. See also CAPACITY.

CALORIMETER, in chemistry, an instrument contrived by Lavoisier and La Place for measuring the comparative quantities of caloric in bodies.

CALTHA, in botany a genus of the Polyandria Polygynia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary none; capsule several, many seeded. There is but one species; *viz.* C. palustris, marsh marigold. This is the first flower that announces the spring in Lapland, where it begins to blow towards the end of May. The variety with very double flowers is preserved in our gardens for its beauty.

CALTROP, in military affairs, an instrument with four iron points, disposed in a triangular form, so that three of them are always on the ground, and the fourth in the air. They are scattered over the ground where the enemy's cavalry is to pass, in order to embarrass them.

CALTROP, in botany, the English name of the tribulus of botanists. See TRIBULUS.

CALVARY, in heraldry, a cross so called, because it resembles the cross on which our Saviour suffered. It is always set upon steps.

CALVINISTS, a sect of Christians who derive their name from John Calvin, an eminent reformer, who was born at Nogen in Picardy, in the year 1509. He first studied the civil laws, and was afterwards made professor of divinity at Geneva, in the year 1536.

The name of Calvinists seems to have been given at first to those who embraced not merely the doctrine, but the church government and discipline established at Geneva, and to distinguish them from the Lutherans. But since the meeting of the synod of Dort the name has been chiefly applied to those who embrace his leading views of the gospel, to distinguish them from the Arminians. The leading principles taught by Calvin were the same as those of Augustin. The main doctrines by which those who are called after his name are distinguished from the Arminians are reduced to five articles; and which, from their being the principal points discussed at the synod, of Dort, have since been denominated the five points. These are predestination, particular redemption, total depravity, effectual calling, and the certain perseverance of the saints.

1. They maintain that God hath chosen a certain number of the fallen race of Adam in Christ, before the foundation of the world, unto eternal glory, according to his immutable purpose, and of his free grace and love, without the least foresight of faith, good works, or any conditions performed by the creature; and that the rest of mankind he was pleased to pass by, and ordain to dishonour and wrath for their sins, to the praise of his vindictive justice.

2. They maintain that though the death of Christ be a most perfect sacrifice and satisfaction for sins of infinite value, abundantly sufficient to expiate the sins of the whole world; and though on this ground the gospel is to be preached to all mankind indiscriminately, yet it was the will of God that Christ, by the blood of the cross, should efficaciously redeem all those, and those only, who were from eternity elected to salvation, and given to him by the Father.

3. They maintain that mankind are totally depraved, in consequence of the fall of the first man, who, being their public head, his sin involved the corruption of all his posterity; and which corruption extends over the whole soul, and renders it unable to turn to God, or to do any thing truly good, and exposes it to his righteous displeasure, both in this world and that which is to come.

4. They maintain that all whom God hath predestinated unto life, he is pleased in his appointed time effectually to call by his word and spirit, out of that state of sin and death in which they are by nature, to grace and salvation by Jesus Christ. They admit that the Holy Spirit, as calling men by the ministry of the gospel, may be resisted; and that where this is the case "the fault is not in the gospel, nor in Christ offered by the gospel, nor in God calling by the gospel, and also conferring various gifts upon them; but in the called themselves. They contend, however, that where men come at the divine call, and are converted, it is not

to be ascribed to themselves, as though by their own free-will they made themselves to differ, but merely to him who delivers them from the power of darkness, and translates them into the kingdom of his dear Son, and whose regenerating influence is certain and efficacious."

Lastly, they maintain that those whom God has effectually called and sanctified by his spirit shall never finally fall from a state of grace. They admit that true believers may fall partially, and would fall totally and finally but for the mercy and faithfulness of God, who keepeth the feet of his saints; also, that he who bestoweth the grace of perseverance bestoweth it by means of reading and hearing the word, meditation, exhortations, threatenings, and promises: but that none of these things imply the possibility of a believer's falling from a state of justification.

Some think Calvin, though right in the main, yet carried things too far: these are commonly known by the name of Moderate Calvinists. Others think he did not go far enough; and these are known by the name of High Calvinists. It is proper to add, that the Calvinistic system includes in it the doctrine of three co-ordinate persons in the Godhead, in one nature; and of two natures in Jesus Christ, forming one person. Justification by faith alone, or justification by the imputed righteousness of Christ, forms also an essential part of this system. They suppose that on the one hand our sins are imputed to Christ, and on the other that we are justified by the imputation of Christ's righteousness to us; that is, Christ, the innocent, was treated by God as if he were guilty, that we, the guilty, might, out of regard to what he did and suffered, be treated as if we were innocent and righteous.

CALVITIES, or CALVITIUM, in medicine, baldness, or want of hair, particularly on the sinciput, occasioned by the moisture of the head, which should feed it, being dried up by some disease, old age, &c.

CALUMET, a mystic kind of pipe used by the American Indians as the ensign of peace, and for religious fumigations. It is made of red, black, or white marble; the head resembles our tobacco-pipes, but larger; and is fixed on a hollow reed, to hold it for smoking: they adorn it with rounds of feathers and locks of hair, or porcupines' quills, and in it they smoke in honour of the sun, especially if they want fair weather or rain. This pipe is a pass and safe conduct amongst all the allies of the nation who has it given: in all embassies the ambassador carries it as an emblem of peace, and it always meets with a profound regard; for the savages are generally persuaded, that a great misfortune would befal them, if they violated the public faith of the calumet.

CALX properly signifies lime, but was formerly used by chemists for a fine powder remaining after the calcination of metals and other mineral substances. The term oxide has now taken place of that of calx. See CALCINATION.

CALYCANTHEMÆ, in botany, the name of the seventeenth order in Linnæus's "Fragments of a Natural Method," consisting of plants which, among other characters, have the corolla and stamina inserted into the calyx.

CALYCANTHUS, in botany, a genus of the Icosandria Polygynia class and order. Essential character: calyx one-leafed, pitcher-form, squarrose, with coloured leaflets; corolla calycine; styles very many, with a glandulous stigma; seeds very many, tailed, within a succulent calyx. There are two species, of which C. floridus, Carolina allspice, is a shrub which rises to the height of eight or ten feet. Where it grows naturally, the bark of this shrub is brown, and has a strong aromatic scent, whence the inhabitants of Carolina give it the name of allspice.

CALYCERA, in botany, a genus of the Syngenesia Segregata class and order. Calyx many-leaved; calycle five-toothed, one-flowered; florets tubular, male and hermaphrodite; receptacle chaffy; seeds naked. One species; *viz.* C. herbacea, found in Chili.

CALYCIFLORÆ, the sixteenth order in Linnæus's "Fragments of a Natural Method," consisting of plants which, as the title imports, have the stamina inserted into the calyx. The plants of this order want the corolla: the flowers are either hermaphrodite and male on the same root, or male and female upon different roots. The seed-vessel is pulpy, of a berry or cherry kind, and contains a single seed or stone.

CALYPTRANTHES, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Onagræ and Myrti, Jussieu. Essential character; calyx superior, truncate, covered with a veil-shaped, deciduous lid; corolla none; berry one-celled, one to four-seeded. There are six species, all natives of the West Indies and Cochin China.

CALYX, among botanists, a general term expressing the cup of a flower, or that part of a plant which surrounds and supports the other parts of the flower. Linnæus describes it to be the termination of the cortical epidermis, or outer bark of the plant, which after accompanying the trunk or stem through all its branches, breaks out with the flower, and is present in the fructification in this new form. He has distinguished it into seven different kinds. 1. A perianth, contiguous to the other parts of the fructification. This is frequently called empalement, or flower-cup, by English writers, and to it, as professor Martyn well observes, should the term cup, if admitted at all, be confined. 2. An involucre, remote from the flower, as in many umbelliferous plants. 3. An amentum, or catkin, from a common, chaffy, gemmaceous receptacle. 4. A spathe, bursting longitudinally. 5. A glume, formed of valves embracing the seed. 6. A calyptra, covering the capsules of mosses like a hood. 7. A volva, a membranaceous covering to the fructification of the fungi. The involucre is rather a number of bractes; and the amentum, a species of inflorescence. See BOTANY.

CAMAX, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla, wheel-shaped; filaments inserted between the segments of the corolla; berry four-celled, many seeded, all villose. There is but one species; *viz.* C. guianensis, is a shrub growing to the height of fifteen feet; it is a native of Guiana, and flowers in January. The inhabitants and negroes use the branches of this shrub for wattling their huts.

CAMBLET, or CAMLET, a plain stuff, composed of a warp and woof, which is manufactured on a loom, with two treddles. There are camblets of several sorts, some of goat's hair, both in the warp and woof; others, in which the warp is of hair, and the woof half hair and half silk; others again, in which both the warp and the woof are of wool; and lastly, some, of which the warp is of wool and the woof of thread. Some are dyed in thread, others are dyed in the piece, others are marked or mixed; some are striped, some waved or watered, and some figured.

Camblets are proper for several uses, according to their different kinds and qualities; some serve to make garments both for men and women; some for bed-curtains; others for household furniture, &c.

CAMBOGIA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Tricoccæ. Guttiferæ, Jussieu. Essential character: corolla four-petalled; calyx four-leaved; pome eight-celled; seeds solitary. There is but one species; *viz.* C. gutta, is a tall tree, with a trunk sometimes as thick as two men can compass, with spreading, opposite branches: native of the East Indies and China; it is very abundant in Siam and Cambodia, where incisions are made in the bark, and a great quantity of gummi guttæ, or gamboge, is extracted and exported into foreign countries; it is very much in use for miniature painting and water colours.

CAMEL, in zoology, a genus of quadrupeds, of the order of Pecora; distinguished from the rest by having no horns. See CAMELUS.

CAMELEON *mineral*, a compound so called on account of the changes of colour which it exhibits. It is prepared from the black oxide of manganese finely levigated, and purified nitre in the proportion of one part of the former to five of the latter. They are to be fused together for half an hour at a high heat, in an earthen crucible. A green mass is produced, which deliquesces by exposure to the atmosphere, and of course requires to be kept in a well-stopped vial. It readily dissolves in hot water, making a dark-green solution. This solution, though kept in a close vessel, will in a few days deposit a yellow powder, and the liquor becomes of a fine blue, which, being diluted with water, assumes a violet colour that afterwards grows red, and finally loses its colour, a grey oxide of manganese being thrown down. By the addition of a few drops of acid to the blue liquor, the change to the red is instantaneous, and the colour is a very beautiful tint, between crimson and pink.

CAMELLIA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Aurantia, Jussieu. Essential character: calyx imbricate, many-leaved; the inner leaflets larger. There are three species, of which C. japonica, Japan rose, is a great and lofty tree, in high esteem with the Japanese for the elegance of its beautiful flowers, which exhibit a great variety of colours, and for its evergreen leaves; but has no scent. It is common in their gardens, flowering from October to April. It varies with single and double flowers, white, red, and purple. It is also a native of China.

CAMELOPARDALIS, the *camelopard, giraffe,* in natural history, a genus of the Mammalia and order Pecora. The generic character; horns covered with a bristly skin, bony and permanent; in the lower jaw eight teeth in front, and on each side the exterior tooth deeply bilobate. There is but one species; *viz.* the Giraffe, which, when fully grown, has been known to attain the extraordinary height among quadrupeds of seventeen feet. Its head is small; its aspect gentle; its fore parts are much higher than those behind; its colours arranged so as particularly to please the eye; and its form, notwithstanding the very great length of the neck, and a general singularity, possesses great beauty and elegance. It is a native of several parts of Africa, living in forests, principally upon the foliage of trees. It is mild and inoffensive, and in all cases of danger has recourse, in the first instance, to flight; when obliged to defend itself, however, it employs very forcible kicking. Its general pace is a brisk trot. Giraffes are sometimes seen in small groups of six or seven. They were first introduced into Europe at the Circean games, by Julius Cæsar, and in the sixteenth century, one was presented to Laurentius de Medicis by the Dey of Tunis. The most accurate describer of this animal is La Vaillant. See Plate IV. fig. 1.

CAMELOPARDALUS, a new constellation of the northern hemisphere, formed by Hevelius, consisting of thirty-two stars, first observed by him. It is situated between Cepheus, Cassiopeia, Perseus, the two Bears, and Draco. See ASTRONOMY.

CAMELUS, *camel,* in natural history, a genus of the Mammalia, of the order Pecora. The generic character: horns none; six front teeth in the lower jaw, thin and broad; the canine teeth distant, three in the upper jaw, and in the lower two; upper lip divided. There are seven species enumerated by Shaw, of which we shall briefly notice the following: C. dromedarius, or Arabian camel: its general appearance, particularly in consequence of the dorsal bunch, gives the idea of deformity, or even of monstrosity; but, in some attitudes, its aspect is far from inelegant. It inhabits various parts of Asia and Africa, is found even in Jamaica and Barbadoes, and is easily domesticated. Even a country, such as Arabia, destitute of water and of verdure, and under a burning sun, where the traveller seldom breathes under a shade, and feels lost in a boundless expanse of desolation, by the assistance of the camel, is rendered habitable, and the seat of independence and comfort. These animals are trained with great assiduity by the Arabs. They will carry a weight of 1200*lbs.*, and have been known to complete a journey of 300 leagues within eight days. They will travel eight or nine days without water, which they scent at the distance of half a league, and drink most copiously when they reach it. Delicate food is far from being requisite for them, and they seem even to prefer the thorns and nettles of the wilderness; and while they find plants to brouse can dispense easily with the want of drink. They have, besides the four stomachs common to all ruminating animals, a fifth, in which they preserve a great quantity of water, unmixed with the liquors of the body and the digestive juices, and from which, by the contraction of certain muscles, they make the water mount into their stomachs and throats to macerate their dry food.

Travellers in the East, when hard pressed with thirst, have killed their camels to obtain a supply from this natural and singular receptacle.

In Turkey, Persia, Arabia, Egypt, and Barbary, camels are almost uniformly employed in the conveyance of merchandise. They are considered as living carriages, and their burden is often not taken off during their sleep. They kneel down to be loaded and unloaded, at the command of their keepers, and are the most patient, laborious, and valuable of slaves. Their milk, and even their flesh, are used by the Arabians for food. Their hair is extremely soft and wrought into a great variety of the most useful and indeed costly stuffs. See Mammalia, Plate IV. fig. 3.

C. bactrianus, the Bactrian camel. This is somewhat larger and swifter than the former, and has on its back two bunches. In the deserts bordering on China it is found wild, as also in the north of India, whence it is imported into Arabia, chiefly for the use of the great and opulent. In China a particular breed of them is distinguished by the designation of "Camels with feet of wind." Fig. 2.

C. glama. These animals have by some authors been called the Peruvian sheep. They are particularly abundant in Peru, feeding in immense herds on the bleakest mountains. Their size is about that of a stag. They were the only beasts of burden among the ancient Peruvians, and will

Scott sc.

Fig.1. Camelopardalis *giraffa*. *camelopard.* *Fig.2.* Camelus *bactrianus*: *Bactrian camel.*
Fig.3. Camelus *dromedarius*: *dromedary* & *Fig.4.* Capra *ægagrus*: *ibex*.

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carry a weight of 150 pounds. This animal can abstain from water four or five days, and may be supported on the coarsest food, and that in very small quantity. When irritated, it endeavours to bite, and ejects an acrimonious and caustic saliva. Its flesh is fat, and excellently flavoured.

C. vicugna, or purplish-brown camel, abounds in the highest mountains of the Indies. It is smaller and more slender than the former, and tamed only with considerable difficulty. It will bear small burdens. Its hair is of admirable softness and silkiness on the breast, particularly wavy and woolly, and extending three inches in length. It is wrought into cloth of the most delicate fineness and beauty. The vicugna and the paco, another species of the camel, are both caught by the Peruvians by the simple process of stretching across the narrow passes of the mountains a cord, with bits of wool attached to it, at small distances, and waving in the wind, which, by the terror or fascination it excites, confines them as effectually as bars of iron.

CAMERA *obscura*, in optics, a machine representing an artificial eye, wherein the images of external objects are exhibited distinctly, in their native colours, either invertedly or erect. See OPTICS.

CAMERARIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, horizontal; seeds inserted into their proper membrane. There are two species, of which C. latifolia, bastard mangeneel, is an elegant tree, about thirty feet in height, abounding with an acrid milky juice; flowers small and white; follicles brown, bivalve in their structure, but not opening. Native of Cuba, Jamaica, and Domingo.

CAMP, the ground upon which an army pitch their tents. It is marked out by the quarter-master-general, who appoints every regiment their ground.

CAMPAIGN, in the art of war, denotes the space of time that an army keeps the field, or is encamped, in opposition to quarters.

CAMPANACEÆ, in botany, bell-shaped flowers. The name of the twenty-ninth order in "Linnæus's Fragments of Natural Method." There are two sections: 1. bell-shaped flowers, with distinct anthers or summits: 2. bell-shaped flowers, with anthers united into a cylinder. The plants of this order are generally herbaceous and perennial. Some of the bell-flowers and bind-weeds are annual; and a few foreign species of the latter have woody stalks.

CAMPANULA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla bell-form, the bottom closed with stamineferous valves; stigma three-cleft; capsule inferior, gaping, with lateral pores. There are seventy-eight species, most of them natives of our own country, well known in the gardens and fields.

CAMPANULACEÆ, in botany, the fourth order of the ninth class of Jussieu's natural orders, so called from their affinity to the genus Campanula. Jussieu gives them the following character: calyx superior, border divided; corolla inserted on the upper part of the calyx, border divided; stamens inserted under the corolla; anthers either distinct or united; germ glandular above; style one; stigma either simple or divided; capsule most commonly five-celled, often many-seeded, and generally opening at its sides; seeds fixed to the interior angle of the cells; stems generally herbaceous; leaves most frequently alternate; flowers distinct, or in a few instances aggregate, and enclosed in a common calyx.

CAMPHOR is a principle of vegetables, which, in many of its properties, resembles the volatile oils. Like them it is odorous, pungent, volatile, inflammable, sparingly soluble in water, and abundantly soluble in alcohol. It differs from them principally in its concrete form, in its peculiar odour, in its relation to the acids and alkalis, and the results of its decomposition by heat. Camphor is a principle contained in many vegetables, especially the aromatic plants, and even those of our own country, as peppermint, rosemary, marjoram, and others: it appears to be volatized in combination with their essential oil in the process of distillation, and, when these are long kept, is deposited in a crystalline form.

The camphor of commerce is procured, however, from a particular plant, the laurus camphora, a native of the east of Asia. It exists ready formed in the wood of this tree, can be seen interspersed through it in vesicles, and can be picked out. It then forms what has been named native camphor. It is usually procured, however, by the process of sublimation. The wood of the stem and branches, cut into small billets, is exposed with a little water to a moderate heat, in a kind of alembic, to the head of which is adapted a capital in which

straw is put. The camphor is volatilized, and attaches itself to the straw. It is a little impure, but is purified in Europe by a second sublimation. The camphor of commerce, from its mode of preparation, is in the form of large semi-spherical cakes: when broken, it appears in fragments of a texture somewhat striated, having a degree of ductility, in consequence of which it can be compressed, and is not easily reduced to powder; of a white colour, and semi-transparent; a little unctuous to the feel; having a very strong, peculiar, and rather fragrant odour, and a taste which is pungent and bitter. It is also susceptible of crystallization: when slowly sublimed, or when slowly precipitated from its solution in water by the affusion of alcohol, it appears in the form of acicular prisms.

Camphor, though a concrete substance, is even more volatile than the essential oils. It evaporates quickly at the common temperature of the atmosphere, losing in weight, and an angular fragment becoming spherical; and at a temperature between 100 and 150, it sublimes in close vessels unchanged. It is highly inflammable, kindles very readily, and burns with the emission of much light, and with a dense black smoke, which condenses into a smooth light charcoal. Carbonic acid gas is produced, and a portion of the peculiar acid which has been named camphoric acid.

Camphor is very sparingly soluble in water. When triturated with it, it merely communicates its smell and taste to the water, which remains odorous, and somewhat pungent, even when filtrated; but no appreciable quantity is dissolved. A phenomenon which has excited some attention is presented, when pieces of camphor are placed on the surface of pure water. They soon begin to move with rapidity, and while moving dissolve, the solution taking place at the line where the water and the air are in contact; as is proved by immersing a cylinder of camphor in water part of its length: it becomes excavated, and at length is cut through, exactly on a level with the surface of the water.

Camphor is abundantly soluble in alcohol: the solution is immediately decomposed, and the camphor precipitated in the form of a white powder, by the affusion of water; but if the water be very slowly added, and merely in such a quantity as to weaken the affinity of the alcohol to the camphor, the latter, in separating, presents a deutritic crystallization. It is also soluble in expressed and essential oils. The alkalis do not dissolve camphor, or produce in it any sensible change. Of the earths, magnesia appears to exert some action on it, as, when they are triturated together, the camphor is reduced to a smooth impalpable powder, which is easily diffused in water. The action of the stronger acids on camphor is peculiar, and presents some singular results.

By distilling nitric acid from camphor, it is more completely changed, and by this process is converted into an acid which has received the name of camphoric acid. The process consists in distilling from four ounces of camphor in a retort, 1 *lb.* of nitric acid, so far diluted as to be of the specific gravity of 1.33, the heat being gradually applied by the medium of a sand-bath: nitric oxide and carbonic acid gases are disengaged; part of the camphor rises in vapour, while the other part receives oxygen from the acid.

Camphoric acid, thus produced, is different from all the known acids. It has a slightly acid bitter taste, and reddens infusion of litmus. Its crystals effloresce on exposure to the air; they are sparingly soluble in cold water, an ounce of water at 50° of Fahrenheit not dissolving more than 6 grains; at 212°, about 48 grains are dissolved. When the acid is placed on ignited fuel, it emits a dense aromatic vapour, and is entirely dissipated. By applying heat to it in close vessels, it first melts and sublimes, but by a higher heat its properties are changed; it no longer reddens litmus, acquires an aromatic smell, its taste is less penetrating, and it is no longer soluble in water, or in sulphuric or muriatic acid. Nitric acid heated on it turns it yellow and dissolves it.

Camphoric acid is soluble in the mineral acids: it is likewise soluble in alcohol, and in the volatile and fixed oils. It produces no change in sulphur. The salts formed by this acid, with the alkaline, earthy, and metallic bases, are named Camphorates. Their properties have been examined by Lagrange. Their taste is somewhat bitter: they are decomposed by heat, the acid being sublimed: and they all exhibit a blue flame when heated before the blow-pipe. The alkaline and earthy camphorates are formed by adding the camphoric acid to the alkali or earth, either pure, or in the state of carbonate; the carbonic acid, in the latter case, being disengaged.

Camphorates, } See the preceding
Camphoric *Acid*, } article.

Camphor *tree*, the tree from which the

camphor of the shops is prepared, being a species of laurel. See LAURUS.

CAMPHORASMA, in botany, from camphora, a genus of the Tetrandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx pitcher-form, two of the teeth opposite, and the alternate ones very small; corolla none; capsule one-seeded. There are five species, of which C. monspeliaca, hairy camphorosma, is an annual plant, with trailing branches, extending a foot or more in length; leaves linear; the flowers are produced from the joints, and are so small as to be scarcely perceptible. Native of France and Spain. The whole plant smells of camphor; it abounds in a volatile oily salt, and is warm and stimulating.

CAMUS, (CHARLES STEPHEN LEWIS) in biography, a celebrated French mathematician, was born at Cressy en Brie, the 25th of August, 1699. His early ingenuity in mechanics and his own intreaties induced his parents to send him to study at a college in Paris, at 10 years of age; where in the space of two years his progress was so great that he was able to give lessons in mathematics, and thus to defray his own expenses at the college without any farther charge to his friends. By the assistance of the celebrated Varignon this youth soon ran through the course of the higher mathematics, and acquired a name among the learned. He made himself more particularly known to the Academy of Sciences in 1727, by his memoir upon the subject of the prize which they had proposed for that year, *viz.* "To determine the most advantageous way of masting ships;" in consequence of which he was named, that year, Adjoint-Mechanician to the Academy; and in 1730 he was appointed Professor of Architecture. In less than three years after he was honoured with the secretaryship of the same; and the 18th of April, 1733, he obtained the degree of Associate in the Academy, where he distinguished himself greatly by his memoirs upon living forces, or bodies in motion acted upon by forces, on the figure of the teeth of wheels and pinions, on pump work, and several other ingenious memoirs.

In 1736 he was sent, in company with Messrs. Clairaut, Maupertuis, and Monnier, upon the celebrated expedition to measure a degree at the north polar circle; in which he rendered himself highly useful, not only as a mathematician, but also as a mechanician and an artist, branches for which he had a remarkable talent.

In 1741, he invented a gauging rod and sliding rule, by which the contents of all kinds of casks might be immediately ascertained. He was employed in works of importance in his own country, and elected Geometrician in the French Academy. In 1765 he was chosen a Fellow of the Royal Society of London. On the 4th of May, 1768, he died in his 69th year, and was succeeded in his office of Geometrician to the Academy by D'Alembert. His works are numerous and of great reputation: the principal are "A Course of Mathematics," "Elements of Mechanics," and "Elements of Arithmetic."

CANAL, an aqueduct made for the purposes of inland navigation. This great improvement in the conveyance of commodities has arrived at a high degree of perfection, and enables us to transport them even over mountains where it would appear impossible to preserve a communication, or rather a continuity of water carriage with the subjacent plains. This is effected by the means of locks built of masonry, each of which serves as the conjunction of two different levels. The locks are made only large enough to admit the vessels employed in the business, and have two gates, one at each end. When a vessel should ascend to a superior level, the upper gate is shut, and the vessel being brought within the lock, the lower gate is also closed, and the upper one opened. By this means the water flows in, and the vessel is raised to the intended height. The upper gate is closed as soon as the vessel has passed, but the water in the lock is preserved for the purpose of letting a vessel down, which is done by shutting the upper gate after she is in the lock, and opening the lower one; so that she is lowered gradually to the next level. The water in all cases is let in or out by means of a small hatch, making its rise and fall very gradual; else the gates would be torn from their hinges by the rush of so large a body, and the vessel would be endangered. We have instances of about twenty locks all in half a mile's distance; but there require very powerful springs to supply a due quantity of water. Sometimes canals are raised above the level of the country; and we have instances where one canal passes over another.

The particular operations necessary for making artificial navigations, depend upon a number of circumstances. The situation of the ground; its vicinity or connection with rivers; the ease or difficulty with

which a proper quantity of water can be obtained: these, and many other circumstances, necessarily produce great variety in the structure of artificial navigations, and augment or diminish the labour and expense of executing them. When the ground is naturally level, and unconnected with rivers, the execution is easy, and the navigation is not liable to be disturbed by floods; but when the ground rises and falls, and cannot be reduced to a level, artificial methods of raising and lowering vessels must be employed, which likewise vary according to circumstances.

In Mr. Donaldson's "View of the Present State of Husbandry," it is observed, that the canals already completed or forming have had wonderful effects upon the agriculture, as well as upon the manufactures and general state of many parts of the kingdom; these, and the navigable rivers, render the carriage of bulky articles more easy and less expensive. The conveyance of manure, fuel, &c. into districts whither, without that medium, they could scarcely have been transmitted, has tended materially to the improvement of these particular districts; and the ease with which the inhabitants can export the produce of the country to otherwise almost inaccessible markets, while it tends to the same end, has also considerable effects on the general markets of the kingdom, and lessons the number of horses that would be requisite for transporting these articles from one place to another.

Owing to some cause or other, inland navigations in many parts of the island have proved ruinous to the adjoining lands; while, in many others, the injury done to the soil in the districts through which these inland navigations are carried, by obstructing the free passage of the rivers to the sea, and by their frequently overflowing their banks, and destroying the crops in the low grounds, is infinitely greater than any commercial advantages that can possibly be derived from them, except by those who are more immediately interested. To render canals, or inland navigations of any sort, of general utility, says he, much circumspection is necessary in framing the acts of Parliament; so that while the commerce of the country is increased, its agriculture may not be injured. It might, he thinks, be a wise regulation, that in every instance without exception, all sorts of manure should be carried at one half or one third of lockage-dues made payable for articles of any other description. Were this point attended to, and minute investigation made as to the probable consequences that were likely to result from granting leave to form canals, and deepen the beds of rivers, for the purpose of inland navigations, these means of lessening the expense of carriage would not so often prove injurious to the best interest of the country,—its agricultural improvement.

It has been well observed by Mr. Middleton, in his able Survey of Middlesex, that "canals calculated to navigate much smaller boats than any which have fallen under his observation, even down to ten tons, might be made at a very reduced expense; and after certain leading ones were executed, every man of considerable landed property would find it to be his interest to make a small canal through his estate, at least capable of floating boats of five tons, which would be equally convenient for bringing manure, and to carry away the produce. In all the marsh and fen districts, most of the present sewers would only want," he thinks, "a little cleansing to fit them for this purpose." And he adds, that "the extension of canals may become the most powerful means of promoting general cultivation. Good roads are certainly very essential, and he thinks canals are at least equally so, in an agricultural view. On the best roads, produce and manure can seldom be carried more than ten miles with profit, at the present price of horse-keep; but if canals were as numerous as roads, corn, hay, manure, &c. could be sent to every part of Britain, without using more road than the towing-paths, and to ten times the former distance without increasing the expense. A general canal-scheme would, says he, tend to equalize the price of every article in life more than all other things put together. It would afford the cheapest, the safest, and speediest conveyance of every article that might be too bulky and heavy for stage and mail coaches. The benefits would be universal in this island. The inhabitants of London and its environs would be infinitely more plentifully and cheaply supplied by canals than by any system of roads whatsoever. The remoter parts of this, and every other country, would be placed more on terms of equality with those that are near, and every other part of the island might reap advantages which may be foreseen, but which are much too great for calculation." And he concludes by remarking, that "canals and

irrigation might be made the means of cultivating every inch of this island, except rocky ground and mountain tops, and these ought to be planted." He states, that "of two methods of raising the money for making canals, the one which seems to deserve the preference is, the mode by which turnpike roads are usually provided for, instead of entrusting it to the management of interested companies. The latter method is exceptionable, from its creating a perpetual charge on all goods sent by that conveyance, without regarding the money expended, or the interest it may ultimately produce, which is a very imprudent bargain for the public in this country, where population, trade, manufactures, and commerce are so much upon the increase."

CANARINA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: calyx six-leaved; corolla six-cleft, bell-form; stigmas six; capsule inferior, six-celled, many-seeded. There are two species, of which C. campanula, Canary bell flower, has a perennial root; stem three feet high; corolla resembling that of a crown imperial, with a yellow eye; style club-form. Native of the Canary Islands.

CANARIUM, in botany, a genus of the Dioecia Pentandria class and order. Essential character: male, calyx two-leaved; corolla three-petalled: female, calyx two-leaved; corolla three-petalled; stigma sessile; drupe with a three-cornered nut. There is but one species; *viz.* C. commune. This tree is a native of the Molucca islands, Banda, and New Guinea. The nuts are eaten both raw and dressed by the inhabitants; an oil is expressed from them, which is used at the table when fresh, and for lamps when stale: bread is also made from them, cakes, biscuits, &c. for the table.

CANARY *bird*. See Fringilla.

CANCER, in astronomy, one of the twelve signs of the zodiac, represented on the globe in the form of a crab, and thus marked (♋) in books. See Astronomy.

Cancer, *tropic of*, in astronomy, a lesser circle of the sphere parallel to the equator, and passing through the beginning of the sign Cancer.

Cancer, the *crab*, in natural history, a genus of insects of the order Aptera. The generic character: eight legs in general, sometimes six or ten, besides two chelated arms; two eyes, distant, in general footstalked, elongated, and moveable; tail unarmed, and jointed. Animals of this genus at particular periods cast their shells, previously to which the limbs shrink, to facilitate their extrication. The loss of a limb, with other animals irreparable, is of little consequence to these, as a few weeks suffice to reproduce one: and in cases of bruise or mutilation, a consciousness of this eventual, and indeed speedy reproduction, induces them violently to rid themselves of the injured member, and to await in seclusion the formation of a complete substitute for it. Some species which are unprovided by nature with any shelly covering, uniformly have recourse to such shells as they find best accommodated to their purpose, and in which their bodies are immersed, while their claws are protruded and unprotected. The correspondence of parts in both sides of almost all other animals is far from being universably observable in these. The claspers on one side are often of extraordinary size, and on the other slender and small; and in some instances the large arm is obliged to be supported by the back of the animal, both while walking and at rest, from its unwieldy and extravagant size. The genus comprehends an immense variety of species; but the chief division is into the Brachyouri and the Macrouri, or the short-tailed and the long-tailed: under the former of which the crab commonly used in this country for food is the principal. It is found chiefly on the rocky coasts. Among the Macrouri, the common lobster is the principal, and a well-known specimen. It inhabits in the clearest water, and at the base of rocks which project over the sea. It is extremely prolific, depositing about 12,000 eggs each time of laying. The warmth of summer is required for maturing them. The C. Norwegicus, or Norwegian crab, is naturally of a pale red colour, and variegated with yellow. It is longer, and more slender than the ordinary lobster. For a representation of it see Entomology, Plate II. fig. 1. C. grapsus, or the streaked crab, is an inhabitant of the American and Indian seas. Its general pale yellow is finely interspersed with red streaks and spots. For a specimen see Entomology, Plate II. fig. 2.

CANCROMA, the *boat-bill*, in natural history, a genus of birds of the order Grallæ. Generic character: bill gibbous, shaped like an inverted boat; nostrils placed in a furrow, and small; tongue small, and toes divided. Of these there seems to be only one species, though Gmelin speaks, somewhat doubtfully indeed, of a second.

The C. cochlearia, or crested boat-bill, is principally found in places near the water. It is a native of South America, particularly abounding in the northern parts of it. Perching on trees which overhang the brooks and rivers, it darts down on the fish swimming underneath, which constitute its chief food. It is supposed, but not ascertained, that it feeds also upon crabs.

CANDLE, a small taper of tallow, wax, or spermaceti; the wick of which is commonly of several threads of cotton, spun and twisted together.

There are two sorts of tallow-candles; the one dipped, the other moulded: the former are the common candles.

Tallow candles should be made of equal parts of bullock's and sheep's fat. The cotton made use of in the manufacture of candles comes from Turkey. This is first wound into rather a fine thread, which is cut into proper lengths, and five, six, or more united, so as to make it of a fit size for the candle required. The machine for cutting the cotton is a smooth board fastened on the knees, and the upper surface is the blade of a razor, aad a round piece of cane, placed at a certain distance from one another, according to the length of the cotton wanted. The cotton is carried round the cane, and being brought to the razor, is instantly separated from the balls. The cotton is then made smooth by pulling, and spread at equal distances, on rods about half an inch in diameter, called broaches. The tallow is melted, and after it is well skimmed, it is brought to the mould, in which the cottons are dipped. The workman holds three of these broaches between his fingers, and immerses the cottons into the melted tallow; these he afterwards hangs up till they become cold and hard, during which others are dipped. When cold they are dipped a second and a third time, and so on till the candles are of the proper size. During the operation the tallow is kept to a proper temperature by means of a small charcoal fire. An invention of modern date has taken off much of the labour of the tallow-chandler: this consists of a beam with fixed pullies, round which ropes are made to pass, and on one end of the ropes can be suspended six or more broaches, the weight of which is balanced by weights in an opposing scale, and which may be increased, as the candles become larger. The workman by this means has only to guide the candles and not to support them between his fingers. Mould candles are so called from their being run or cast in moulds made of pewter. In these the cotton is introduced by means of a wire, and kept in a perpendicular position, till the tallow is poured in, and when cold the candles are easily drawn out.

Wax candles are made of a cotton or flaxen wick, slightly twisted, and covered with white or yellow wax. Of these, there are several kinds; some of a conical figure, used to illumine churches, and in processions, funeral ceremonies, &c. Others of a cylindrical form, used on ordinary occasions. The first are either made with a ladle or the hand: to make wax candles with the ladle. The wicks being prepared, a dozen of them are tied by the neck, at equal distances, round an iron circle, suspended directly over a large bason of copper tinned, and full of melted wax: a large ladle full of this wax is poured gently on the tops of the wicks one after another, and this operation continued till the candle arrive at its destined bigness, with this precaution, that the three first ladles be poured on at the top of the wick; the fourth at the height of $\frac{3}{4}$; the fifth at $\frac{1}{2}$; and the sixth at $\frac{1}{4}$; in order to give the candle its pyramidal form. Then the candles are taken down, kept warm, and rolled and smoothed upon a walnut-tree table, with a long square instrument of box, smooth at the bottom.

As to the manner of making wax-candles by the hand, they begin to soften the wax, by working it several times in hot water, contained in a narrow, but deep caldron. A piece of the wax is then taken out, and disposed, by little and little, around the wick, which is hung on a hook in the wall, by the extremity opposite to the neck; so that they begin with the big end, diminishing still as they descend towards the neck. In other respects, the method is nearly the same as in the former case. However it must be observed, that in the former case, water is always used to moisten the several instruments, to prevent the wax from sticking; and in the latter, oil of olives, or lard, for the hands, &c. The cylindrical wax-candles are either made, as the former, with a ladle, or drawn. Wax-candles drawn, are so called, because actually drawn in the manner of wire, by means of two large rollers of wood, turned by a handle, which turning backwards and forwards several times, pass the wick through melted wax contained in a brass bason, and at the same time through the holes

of an instrument like that used for drawing wire fastened at one side of the bason.

CANDLES, *sale or auction by inch of*, is when a small piece of candle being lighted, the bystanders are allowed to bid for the merchandise that is selling; but the moment the candle is out, the commodity is adjudged to the last bidder.

CANDLE *berry-tree*, in botany. See MYRICA.

CANDLEMAS, a feast of the church, held on the second day of February, in honour of the purification of the Virgin Mary. It is borrowed from the practice of the ancient Christians, who on that day used abundance of lights both in their churches and processions, in memory, as is supposed, of our Saviour's being on that day declared by Simeon, "to be a light to lighten the Gentiles." In imitation of this custom, the Roman Catholics, on this day, consecrate all the tapers and candles which they use in their churches during the whole year.

CANDY, or *sugar* CANDY, a preparation of sugar, made by melting and crystallizing it six or seven times over, to render it hard and transparent. It is of three kinds, white, yellow, and red. The white comes from the loaf-sugar, the yellow from the cassonado, and red from the muscovado.

CANE is the name of a long measure, which differs according to the several countries where it is used. At Naples, the cane is equal to 7 feet $3\frac{1}{2}$ inches English measure: the cane of Toulouse, and the upper Languedoc, is equal to the varre of Arragon, and contains 5 feet $8\frac{2}{3}$ inches: at Montpelier, Provence, Dauphine, and the lower Languedoc, to 6 English feet $5\frac{1}{2}$ inches.

CANELLA, in botany, a genus of the Dodecandria Monogynia class and order. Essential character: calyx three-lobed; corolla five-petalled; anthers twenty-one, fastened to a pitcher-shaped nectary; berry three-celled; seeds two to four. There is but one species, *viz.* C. alba, laurel leaved canella, is a tree, the stem of which rises from ten to fifty feet in height, straight, upright, branching only at the top. The flowers grow at the tops of the branches in clusters, upon divided peduncles. It is common in most of the West India islands. The whole tree is very aromatic, and when in blossom perfumes the whole neighbourhood. The flowers, dried and softened again in warm water, have a fragrant odour, resembling that of musk.

CANEPHORA, in botany, a genus of the Pentandria Monogynia class and order: common calyx tubular, toothed, many flowered: perianthum five or six-cleft; corolla campanulate, five or six-cleft; fruit inferior, two-seeded. There are two species, *viz.* the axillaris and capitata, natives of Madagascar.

CANES, *walking*, are said by Bradley to be joints of the roots of a sort of reed, called canna Indica. This plant shoots in joints of about three or four feet long, near the surface of the ground, and at every knot produce great numbers of fibres, by which it receives its nourishment. The joints are made straight by the fire, which occasions those shades or clouds frequently seen in them. Bradley thinks the cane-tree might be propagated here by planting some of the roots with their knots in artificial bogs, &c.

CANES, *rattan*, are a smaller sort brought from China, Japan, and Sumatra, very tough; which being split, are used for making of cane chairs. They are the produce of a reed called rattang malabarica minor, or lesser rattan. The specific name is rotang, whence rattan, and in the Malayan language signifies a staff or walking stick. These, when dry, being struck against each other, will give fire, and are used accordingly in some places in lieu of flint and steel. Being twisted together they make cordage of them. The Chinese and Japanese vessels are said to have their cables made of them, which are less liable to rot in the water than hemp.

CANES *venatici*, in astronomy, the greyhounds, two new constellations first established by Hevelius between the tail of the great Bear, and the arm of Bootes, above the Corona Berenices. That next the Bear's tail is called Asterion, the other Chara.

CANICULA, or CANICULUS, in astronomy, the same as the Canis Minor. See CANIS MINOR.

It is also a name given to one of the stars of the constellation Canis Major, called the Dog-star, and by the Greeks Sirius.

CANICULAR *days*, commonly called dog-days, a certain number of days preceding and ensuing the heliacal rising of the Canicula, or the Dog-star, in the morning. The Ethiopians and Egyptians began their year at the rising of the Dog-star, reckoning to its rise again the next year, which is called the annus canarius. The Romans supposed it to be the cause of the sultry weather usually felt in the dog-days; and, there-

fore, sacrificed a brown dog every year at its rising to appease its wrath.

CANINE *teeth*, in anatomy, are two sharp-edged teeth in each jaw; one on each side, placed between the incisores and molares.

CANINE *muscles*, a pair of muscles common to both lips. They arise from the hollow on each side under the os jugalis, in the os maxillare, and are inserted into the angle of the lips.

CANIS, the dog, in natural history, a genus of Mammalia, of the order Feræ. Generic character: six upper foreteeth; lateral ones longer, distant; the intermediate ones lobate; in the lower jaw six, lateral ones lobated; tusks solitary and incurvated; grinders six or seven, or more than in other genera of this order.

This genus is distinguished by its voracity and by tearing what it devours. It is unable to climb trees; can move with great swiftness; has the crown of its head usually flat, with a lengthened snout; its body very considerably thicker before than behind; its claws are long, somewhat curved, but not retractile. The female produces many at a time, and has usually four teats on the breast and six on the belly. In the savage state of the dog, his irritable and ferocious character renders him a dangerous enemy to other animals, but when domesticated, his grand object appears to be to please his employers, and to convert to their service his courage, his swiftness, and all his striking and valuable instincts. He is extremely docile, and accommodates himself to the manners and habits of those with whom he lives, with a facility which furnishes an admirable lesson. His vigilance over whatever is committed to his charge is connected with a courage in defence of it, arising even to rage. His suspicions are perpetually alive: his inferences, with respect to the just grounds of apprehension, are astonishingly judicious and correct, and he not only sounds the tocsin of alarm to the whole family by which he is employed as centinel, but darts on a supposed culprit with a vigour and intrepidity which generally overwhelm the power of resistance. By the assistance of the dog, man has reduced the other animals to slavery. Dangerous and ferocious beasts are hunted down by its means. By conciliating, among the various animals by which he was surrounded, those, which at the same time that they abound in energies are also capable of affection and obedience, man has been enabled to oppose and destroy others with which he would have been able to establish no compromise, whose ferocity is untameable, and whose power is connected only with ravage and desolation. The training of the dog was probably one of the first objects of the attention of man, and aided him extremely in subduing the earth to his unmolested government.

The capability of instruction, and the imitative powers of the dog, have furnished innumerable curious and interesting anecdotes. A Florentine nobleman possessed a dog which would attend his table and change his plates, and carry his wine to him with the utmost steadiness, and the most accurate attention to his master's notices.

It is related by the illustrious Leibnitz, that a Saxon peasant was in possession of a dog of the middling size, and about three years of age, which the peasant's son, perceiving accidentally, as he imagined, some resemblance in its sounds to those of the human voice, attempted to teach it to speak. By the perseverance of the lad, the dog acquired the power, we are told, of pronouncing about thirty words. It would, however, exercise this extraordinary faculty only with reluctance, the words being first spoken always by the preceptor, and then echoed by the pupil. The circumstance is attested by Leibnitz, who himself heard it speak, and was communicated by him in a memoir to the Royal Academy of France.

In the theatre of Marcellus, what many will consider more probable, but what is still extraordinary, is mentioned to have occurred, by Plutarch. A dog was here exhibited who excelled in various dances of great complication and difficulty, and represented also the effects of disease and pain, upon the frame in all the contortions of countenance and writhings of the body, from the first access to that paroxysm, which often immediately precedes dissolution; having thus apparently expired in agony, he would suffer himself to be carried about motionless, as in a state of death, and after a sufficient continuance of the jest, he would burst upon the spectators with an animation and sportiveness, which formed a very interesting conclusion of this curious interlude, by which the animal seemed to enjoy the success of his scenic efforts, and to be delighted with the admiration which was liberally and universally bestowed upon men.

Fig. 1. Canis *familiaris: shepherds' dog. Fig. 2. Australasian dog. Fig. 3. Pomeranian dog. Fig. 4. Siberian dog. Fig. 5. Iceland dog. Fig. 6. Great Barbet, or water dog.*

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This genus comprehends twenty-one species, several of which, particularly the C. familiaris, include numerous varieties. The following appear principally deserving of notice.

The C. familiaris, or the familiar dog, of which the variety known by the name of the shepherd's dog is imagined to approach most nearly to the original animal. Its use is inferible from its designation. It keeps the flock collected, and defends it from injury. In the Alps, and some other regions of Europe, it is considerably larger and stronger than in England. See Mammalia, Plate V. fig. 1.

Another variety is the dingo, Australasian, or New Holland dog. Plate V. fig. 2. This dog does not bark so readily as the European dogs: its appearance much resembles the larger kind of the shepherd's dog, and it is extremely fierce and untractable.

The Pomeranian dog, another variety, is generally white, and is distinguished, among several characteristics, by the curvature of its tail, extending very nearly to a circle. Plate V. fig. 3.

A fourth variety is the Siberian. These dogs are frequently employed in Siberia and Kamtschatka, in drawing sledges on the frozen snow, and four or six of them yoked to a sledge will convey three persons, with the usual quantity of baggage, forty miles or more in a day. The exertions of these dogs, however, are more to be praised than their fidelity or attachment. Their perverseness and subtlety are a source of great vexation to their employers, who, however, notwithstanding the malignity and cunning they are thus so incessantly called upon to counteract, find these animals indispensable to the convenience and intercourse of these arctic regions. See Plate V. fig. 4.

The Iceland dog is but little different from the last, as will be seen by a reference to Plate V. fig. 5. Its general colour is black.

For the great barbet see Plate V. fig. 6.

The blood-hound was, some ages since, highly esteemed in England, and much employed in the pursuit of robbers. The acuteness of its smell is so extraordinary, that it has traced a man to the distance of seven miles, along a much frequented highway, and through several market towns, to the very upper room in which he was taking refreshment.

The Irish grey-hound, now extremely rare even in Ireland itself, is perhaps the most beautiful and majestic, as well as the largest of all dogs. It was this dog which was principally employed in clearing the island of wolves. It is, however, unfit for hunting foxes, hares, or stags, and is kept by a few persons merely for its beauty and size. Dr. Goldsmith had seen one four feet high.

The mastiff, another variety, is of a very strong and thick structure, with a large head, and the sides of the lips pendulous. In the reign of James I. a trial of its vigour and courage was made in the Tower of London, and three mastiffs being opposed to a lion, two were mutilated and disabled, but the third obliged the lion to have recourse to flight.

The terrier, another variety, is much employed in unearthing foxes, and to all those quadrupeds which are comprehended in the class of Vermin, bears the strongest antipathy. A well-trained terrier is frequently found an over-match even for the fierce and hardy badger. This dog is extremely useful as an attendant on every pack of hounds, to compel the game from its close cover of earth or thicket.

The chief peculiarities of the species of which these few varieties out of many have been given are these. It cultivates the society of man, has rarely been found wild; feeds on flesh and farinaceous vegetables, but not on greens; it digests bones; urines frequently, holding up its leg; dungs upon a stone; vomits itself by grass; runs in an oblique direction; very rarely sweats, but lolls out its tongue when hot. The male young resemble the dog, and the female the bitch. It is extremely docile, affectionate, and vigilant in its intercourse with man; it eats with a glancing and envious eye; has a great aversion to strangers, and particularly to beggars; licks wounds; hears and dreams in its sleep, sets up a howl on hearing musical sounds, and bites stones thrown at it; it possesses a most acute sense of smell; is liable to gonorrhœa; is subject also to madness, which it imparts by biting, and in old age is addicted to gnawing itself. It is regarded by the followers of Mahomet as unclean.

C. Lupus, the wolf. These animals are found in almost all the temperate and cold climates of the globe. They abounded formerly in Great Britain and Ireland, but were extirpated by government's commuting the punishments for several offences for a proportionate number of wolves'

tongues, or by the substitution in Wales of a certain number of wolves' heads for a particular amount of money in taxes. Some lands were also held on condition of the occupiers destroying yearly a certain number of these dangerous animals.

In America, wolves are reported to go in droves, and to hunt various animals with the most terrific and hideous howlings, not scrupling when urged by hunger, to attack even the buffaloe itself. To allay their hunger, it is stated that they will swallow large quantities of mud. In Sweden the carcases of animals are purposely laid in their way, stuffed with tree moss, and pounded glass, which render the repast fatal to them. They are, like the dog, subject to madness, communicated also by bite, but generally coming on in winter rather than in summer. In the north of Europe they live much on seals, and extending their excursions far on the ice, when that is detached, in consequence of a change of weather, from the land, they are carried off into the ocean, and express the sense of their dreadful and insuperable danger, by the most bitter howlings of despair.

There is no animal whose carnivorous appetite is stronger than that of the wolf, and he is endowed by nature with all the means of satisfying it, being strong, agile, subtle, and enabled not only to explore, but to seize and subdue his prey.

By the perpetual war in which he is involved with man, however, he is often reduced to extreme difficulties, and driven far into wilds and forests, where the means of satisfying his appetite are scarcely to be found : remoteness from human habitation, in proportion as it adds to his scarcity, embarrasses his subsistence. The urgency of his wants drives him back to those dangers which he was eager to shun, and inspires him often with courage by no means natural to him, and rising to all the vehemence of fury and distraction. He will in these circumstances of pressure make no scruple of attacking women and children, and occasionally assault and devour men. The Paris gazette for 1764, states the ravages and devastation by one of these creatures, near Languedoc, to have comprehended the destruction of no less than twenty persons. It will devour its own species as well as the human. It is remarkable for suspicion, for terror at the sound of a trumpet, for exquisite acuteness of smell, for its endurance of extreme cold and hunger, for its fearfulness of a cord or rope drawn along the ground, and for leaping over fences rather than passing through doors or gates. When taken young, its savage character has, by assiduous education, been not merely greatly mitigated, but, in a few instances, completely subdued. The time of gestation in the wolf is 100 days, being forty more than that of the dog, which may be considered as a radical difference between these species of animals. See Mammalia, Plate VI, fig. 2.

C. hyæna, or the striped hyæna. These animals are generally about the size of a large dog, and abound in many parts of Asia and Africa. They have been almost universally believed to be untameable, but several decided instances to the contrary have occurred. Their manners, however, are particularly untractable and ferocious, and truly indicated by that unremitted gloom and malice expressed in their countenance. They inhabit, principally, rocks and caves, and, shunning the light of day, avail themselves of darkness to commit their depredations. They feed not only on prey which they have themselves killed, but putrid carcases supply them with a delicious banquet, and the bodies of the dead are often, with most persevering labour, torn up from their graves in churchyards, where they have some time been deposited, and devoured with the keenest relish. They follow the motions of contending armies, anticipating by the associations, furnished from experience, and which are formed in the inferior animals as well as in man, the feast to be supplied from human conflict and carnage. When they are first put in motion they appear, as is not uncommon with dogs, to labour under some fracture or dislocation in their hind legs. This, however, in a short time, totally vanishes. In Syria, and about Algiers, they live much, if not principally, on bulbous roots, in the choice of which they are uncommonly fastidious. In Barbary, the Moors will not hesitate to pull the hyæna by the ears in the day time, and, indeed, experience from it no attempt at injury : they will even enter his cave with a torch, and throwing a blanket over him, hawl him out without any inconvenience. In the same country some small animals have been shut up with a hyæna fasting, during a whole day, and yet have been found alive and uninjured ; but by night a young ass, a goat, and a fox, locked up with one, were destroyed, and, excepting some of the larger bones of the ass, completely devoured before morning.

In Abyssinia these animals are nearly equally active and bold by day and night. They abound in every part, and are scarcely less numerous even than sheep. Mr. Bruce complains of their being the plague of his life in that country, the terror of his night-walks, and the destruction of his mules and asses, which were, with them, a favourite food. One night, having, for a moment, quitted his tent, where he had previously heard some noise within it, the cause of which, however, he was unable to discover, and had ceased to think of, he observed on his return, in the dark, two large blue eyes, most fixedly glaring on him. A light being speedily brought, he discovered near the head of his bed a hyæna, with several bundles of candles in his mouth. Mr. Bruce immediately struck at him with a long pike, which penetrated completely through him, near his heart. The animal no sooner felt the smarting of the wound, than he appeared animated by the most fierce and desperate vengeance, and strove actually to climb up the shaft of the pike to reach his destroyer. The servant, however, cleft his head asunder with a battle-axe. Plate VI. fig. 1.

C. aureus, the jackal. In the warm latitudes of Asia and Africa these animals abound, and no where more than in Barbary. The jackal is of a light yellow colour, with black shades about the back and legs; and about the size of a middling dog. In its excursions, which are chiefly during night, it commits promiscuous ravage among the more defenceless animals, though vegetables are sometimes used for food by it. Jackals frequently assemble in large droves or troops, even so numerous as two hundred, and hunt the vast herds of deer or antelopes which abound in these regions, sounding the most horrid yells, and pursuing their prey till it sinks under the exhaustion of fatigue and terror. The feast of the jackals, however, is generally intercepted, or at least delayed, by the appearance of the lion, who roused by their sounds, and aware that they are preparing a banquet which he may enjoy at his leisure, follows their footsteps. While he gratifies his appetite these humble and trembling purveyors await at a distance the moment when the lord of the forest shall have completed his repast, and they may safely approach to devour the mutilated remains he was unable to dispose of.

It is supposed by some judicious and sagacious naturalists, that the jackal is the real origin of the dog. In the structure of the short intestine called the cæcum, they both agree, and their instinct and manners are extremely similar. They both are fond of the society of man, and approach on being called by their names. The jackal is easily tamed, and shows an attachment to dogs; it fawns on its owner, and exhibits all those indications of joy, sportiveness, and gratitude, which characterize the dog. The jackal and the dog also readily intermix. The wolf and the fox naturally shun mankind. The native regions of the wolf also are those of extreme cold, which do not suit the dog; and the construction of some of the intestines of the fox is extremely different from those answering similar purposes in dogs. The different times of gestation, however, in the jackal, and in the dog, appears no slight objection to the theory thus advocated. Plate VI. fig. 3.

C. vulpes, the fox. This animal is generally of a yellowish brown colour, with its tail straight, bushy, and tipped with white, from the base of which it emits a rank and fetid odour. The skill of the fox in the construction of its mansion ranks it among the higher order of quadrupeds. He burrows under firm earth, and often where the roof of his dwelling is prevented from falling in by the wattling of the roots of trees. His subterraneous residence is generally extensive, and he provides to it several avenues for his convenience or security. Thus, instead of being a houseless vagrant, he possesses all the ideas and comforts which attach to a home, and which are justly supposed to imply superior sentiment and intelligence.

The fox is not unfrequently observed, in fine weather, to quit his retreat, and bask at his full length in the sun. His ravages are reserved for the night, and are generally committed at a distance from his home. He destroys for his food various species of vermin. Poultry and young lambs very frequently fall under his power, where he has secure access to them. The dung of other animals, berries, snails, frogs, and insects, are sometimes taken by him. Of grapes he is proverbially fond, and the vineyards suffer very considerably from his depredations. He wastes or destroys far more than he devours, often hiding large quantities of his prey in thickets, or beneath the roots of trees. His sagacity to discern his prey and his enemies is extraordinary. In Palestine, foxes certainly

abound; but, from the narrative of Samson's firebrands, might be supposed still more abundant. The animals employed by him in that destructive stratagem were probably jackals, which are at least equally abundant, and far more easily accessible. In very northern latitudes, the fox is frequently black, and affords a fur more valued than that of almost any other animal: it has been sometimes sold from Kamtschatka for 400 rubles. The fox has been sometimes found perfectly white. The arctic fox, found particularly in Nova Zembla, is one of the hardiest of all animals, unremitted in its pursuit of prey during the severest rigours of winter. In some parts it is compelled to sustain itself by berries, shell-fish, or whatever is thrown up by the sea. In others, the sustenance of these animals consists of wild geese, and every kind of water-fowls, with their eggs; and in Lapland, particularly, they feed upon a species of mice called lemings, which, being migratory at uncertain periods, induce the consequent migrations of the arctic fox, who will, in the pursuit of this prey, be absent from his native country sometimes for three, or even four years. The ground in Spitzbergen being eternally frozen, these animals being consequently here unable to burrow, reside in the cliffs of rocks, and two or three are often found in the same hole. The cunning supposed to be characteristic of the fox, and which it might be supposed that embarrassment and hardship would increase, is by no means a quality of the variety under consideration, which is indeed rather noted for its simplicity; instances having been known in which the arctic fox, after standing by while a trap was baited, has immediately thrust his head into it. The Greenlanders convert the skins of these animals, which are light and warm, but not lasting, to the purposes of merchandize, manufacturing some of the thicker and harder parts into buttons. They occasionally eat the flesh, and the tendons are divided by them into slender filaments, and substituted for thread. For a representation of the fox. See Mammalia, Plate VI. fig. 4.

CANIS *Major*, in astronomy, a constellation of the southern hemisphere.

CANIS *Minor*, *Caniculus*, or *Canicula*, in astronomy, a constellation of the northern hemisphere. See ASTRONOMY.

CANKER, a disease incident to trees, proceeding chiefly from the nature of the soil. It makes the bark rot and fall.

CANNA, in botany, *Indian flowering reed*, or *Indian shot*, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: corolla six-parted, erect; lip two-parted, revolute; style lanceolate, growing to the corolla; calyx three-leaved. There are five species, most of them natives of the northern provinces of America.

CANNABIS, in botany, *English hemp*, a genus of the Dioecia Pentandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: male, calyx five-parted; corolla none; female, calyx one-leafed, entire, gaping on one side; corolla none; styles two; nut bivalve, within the closed calyx. There is but one species, *viz.* C. sativa. The uses of hemp are well known, as well as its great importance to the navy for sails and cordage. Exceedingly good huckaback is made from it for towels and common table-cloths. The low-priced hempen cloths are a general wear for husbandmen, servants, and labouring manufacturers. The hemp raised in England is not of so dry and spongy a nature as what we have from Russia, and therefore it requires a smaller proportion of tar to manufacture it into cordage. English hemp, properly manufactured, stands unrivalled in its strength, and is superior to the Russian. Like many other plants, generally cultivated, it is difficult to ascertain the original place of its native growth. Linnæus gives it to the East Indies and Japan.

CANNEL *coal*. See AMPELITES.

CANNON, in the military art, an engine or fire-arm for throwing iron, lead, or stone bullets by force of gunpowder. Cannons at first were called bombardæ, from the noise they made: they had likewise the name of culverin, basilisk, &c. from the beasts that were represented upon them; and the Spaniards, from devotion, gave them the name of saints; witness the twelve apostles which Charles V. ordered to be cast at Malaga, for his expedition to Tunis.

Cannon are classed as field-pieces or battering-pieces; the former are usually made of mixed metals, but sometimes of pure brass; the latter, with very few exceptions, are of cast iron. Every cannon is made by running fused metal into a mold, and is afterwards finished by being turned on a lathe. The chace is bored by means of a strong machine. Some suspend the cannon vertically over the borer, making it press downwards as the borer revolves; others have a horizontal process in which the can-

non is firmly fixed on a frame, and the borer approaches as the chace proceeds. There is a large cylindrical projection on each side of a cannon, nearly in the middle of its length; these are called trunnions, they serve to support it on the carriage, and as pivots, whereon a due degree of elevation or depression may be given. This variation in the elevation is made in field-pieces which usually carry balls of 3, 6, 9, 12, and up to 18*lb.* weight, by means of a screw fixed to a strong piece of wood that joins the two cheeks of the carriage, and is fastened by a loop and bolt to the round knob at the end of the cannon, called the cascabel. As there is great force in the powder when ignited by means of a match applied to the vent, which communicates with the end of the chace, the quantity of metal must, of necessity, be augmented about the breech, or hinder parts. Thus all cannons are fortified in that part; but battering cannons are generally double-fortified, by an additional quantity of metal, in consequence of the large charges of powder given for the purpose of adding to the impetus or force of the shot's action on the place to be battered.

Battering-pieces are generally from 24 to 42 pounders, sometimes 18 pounders are used, but their effect is feeble compared with that of cannons of a larger calibre.

Cannon intended for field service are mounted on a carriage, with two stout wheels about four feet and a half high, on a solid wooden, or an iron axle, and suspended by their trunnions on the two cheeks, which are as near to each other as the size of the cannon will permit, tapering down a little towards the ground at a sufficient angle to oppose the recoil, or run backward, made by every piece when fired. The cheeks diverge a little, and are kept very firm in their places by means of cross pieces called transoms, which are vertical in and secured by strong bolts. The cannon is turned about to any direction by means of a hand-spike which fixes into the train. The piece is transported by raising its train, and passing the tail-transom, which is perforated for the purpose, on to a very substantial iron gudgeon firmly fixed on the centre of an axle, which has two wheels rather lower than those of the carriage. This appendage is called a limber, and carries a stout water-proof box full of ammunition of various descriptions, for the service of the cannon; it has likewise a pole, or shafts, whereby horses are attached, and the piece thus travels with tolerable ease; the limber wheels traversing under the cheeks of the carriage.

The modes of charging cannon are various, but in general with cartridges, over which wads of spun yarn are well rammed; then the shot, either round or grape; and, lastly, a second wad rammed home: but in field service, where grape or cannister shot are used, the whole charge is sometimes made to fit in immediately after the cartridge, which is invariably made of surge, shalloon, or other woollen stuff. Grape is made by putting many small balls together so as to fit the bore of the piece; they are usually netted to a round piece of board. Cannister is nothing more than a number of still smaller balls put into a tin cannister; these are intended for close attacks, especially among cavalry, or large bodies of infantry: round shot being more suited to distant operations. Ship guns, and such others as are intended to be stationary, are placed on low substantial carriages, moving on four small trucks; these are elevated by means of wedges called quoins. Some are discharged by locks, on the same principles as those for musquets; and for ship use are certainly the safest, and best adapted to a certainty of aim. Brass six-pounders often weigh so little as 4*cwt.* but some of the double fortified battering cannon amount to full 3 *tons* each.

A short kind of cannon called a carronade is much in naval use: we have some that throw balls of near 70*lbs*: their purpose is chiefly for close attacks, when their effects are dreadful: these slide in grooves on a bed carriage. The pieces used for throwing shells, which are hollow balls filled with powder that explode when the fuse burns into them, are howitzers and mortars; the former are mounted in every respect similar to cannon, but are very short and chambered. These throw either shells or grape with great effect. The mortar is always fired at an elevation of 45 degrees from the horizon, and its range, *i. e.* the distance at which the shell is to fall, is determined by putting a greater or less charge of powder into the chamber. Shells for mortars sometimes measure a diameter of 21 inches, but those for howitzers rarely exceed 11 inches, and generally are from $4\frac{1}{4}$ to $8\frac{1}{2}$, or thereabouts. The point blank range of a cannon is that distance at which the shot cuts a line, supposed to be drawn parallel with the surface of earth, at a distance equal to the height of the chace of the cannon when horizontal. No shot goes in a right line

from the muzzle to the object, but forms a curve often many yards above the horizontal line. The point blank distance is according to the calibre of the piece, and the proportion of powder, and its quality, used for a charge; we may, however, state the ranges to be from 400 to 1000 yards.

Mortars will throw shells more than a mile. The carriage of a mortar is a large horizontal bed of timber, strongly clamped together, and placed on loose sand; it should be perfectly level. The breech of a mortar is round, and rests in a hollow made in the centre of the bed; its muzzle is held up by a curved iron stay, which being acted upon by a screw gives the mortar more or less elevation: the trunnions are close to the breech, and move upon the bed.

We shall conclude this article with a short description of the method of cannon boring.

Fig. 1. Plate Cannon, &c. is an elevation of a machine for boring cannon; and fig. 2. is a plan of it; the same references are used in both figures: A is a cast iron frame to support the bearing for an iron shaft, B, turned by a steam engine or water wheel, this has a square box on its end, into which a square knob cast on the end of the gun is fitted by screws; the mouth of the gun is supported on an iron frame, D, sliding on the two bed beams, E, E, and can be fixed at any place by screws; it has also screws to elevate or depress the brass which forms the bearing for the gun: F is the boring bar fastened at its end to a large block, G, running on the bed beams with small wheels: H is a rack fastened by its ends to puppets wedged on the bed, passing through the block G: a pinion which works in this rack, is attached to the block G, and its spindle has a wheel, I, with pins projecting from it: K is a bar going between these pins, and carrying a weight which turns the pinion, and forces the block G, and the boring bar towards the gun. When the weight reaches the ground it must be lifted up, and its lever, K, hooked between two fresh pins of the wheel.

Cannon, with letter-founders and printers, a large sized letter distinguished by this name.

CANNONADE, in marine affairs, is the application of artillery to the purposes of naval war, or, the direction of its efforts against some distant objects intended to be seized or destroyed, as a ship, battery, fortress, &c.

CANNULA, in surgery, a tube made of different metals, principally of silver and lead, but sometimes of iron.

CANOE, a small boat, made of the trunk of a tree, bored hollow; and sometimes also of pieces of bark, sewed together. It is used by the natives of America to go a fishing in the sea, or upon some other expedition, either by sea, or upon the rivers and lakes.

CANON, commonly called prebendary, a person who possesses a prebend, or revenue allotted for the performance of divine service in a cathedral or collegiate church. Originally, canons were only priests, or inferior ecclesiastics, who lived in community, residing near the cathedral church to assist the bishop, depending entirely on his will, supported by the revenues of his bishopric, and living in the same house as his domestics or counsellors, &c. By degrees, these communities of priests, shaking off their dependance, formed separate bodies; in time they freed themselves from their rules, and at length ceased to live in a community. It is maintained that the colleges of canons, which have been introduced into each cathedral, were not in the ancient church, but are of modern appointment.

Canon, in an ecclesiastical sense, a law, rule, or regulation of the policy and discipline of a church, made by councils either general, national, or provincial.

Canon *of scripture*, a catalogue or list of the inspired writings or such books of the bible as are called canonical; because they are in the number of those books which are looked upon as sacred, in opposition to those which are either not acknowledged as divine books, or are rejected as heretical and spurious, and are called apocryphal. This canon may be considered as Jewish and Christian, with respect to the sacred writings acknowledged as such by the Jews, and those admitted by the Christians.

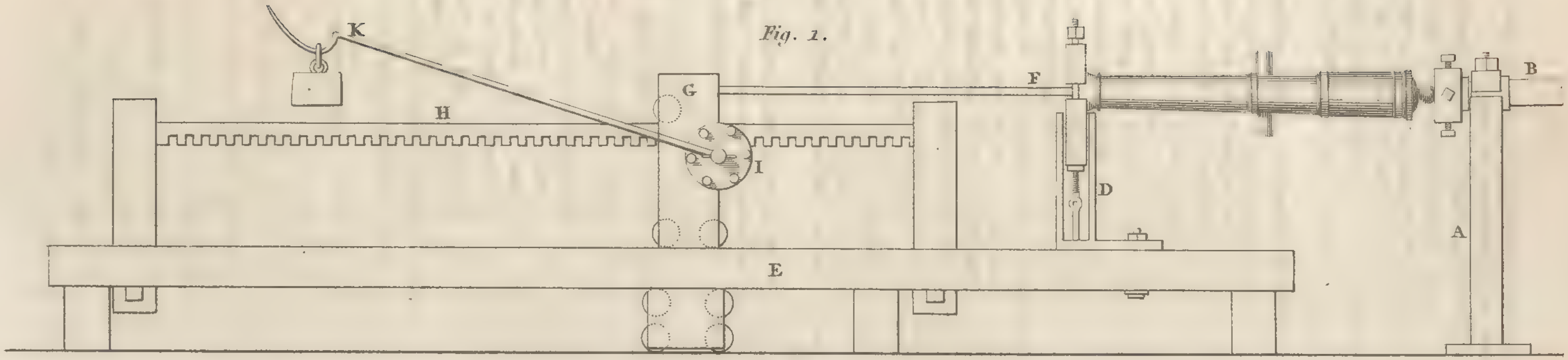
Canon, in music, a short composition of two or more parts, in which one leads, and the other follows: or it is a line of any length, shewing, by its divisions, how musical intervals are distinguished, according to the ratios, or proportions, that the sounds terminating the intervals, bear one to another, when considered according to their degree of being acute or grave.

Canon, in arithmetic, algebra, &c. is a rule to solve all things of the same nature with the present inquiry; thus, every last step of an equation in algebra is such a

CANNON BORING.

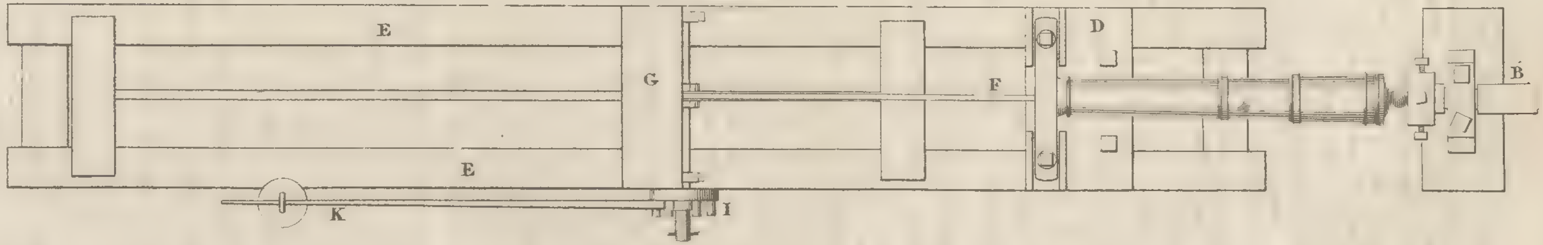
Elevation.

Fig. 1.



Plan

Fig. 2.



J. Farey Jun.r delin.

Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, March 1, 1808.

canon; and, if turned into words, is a rule to solve all questions of the same nature with that proposed. Tables of logarithms, artificial sines and tangents, are called likewise by the name of canon.

CANON *law*, a collection of ecclesiastical laws, serving as the rule and measure of church government.

CANONS *of the apostles*, a collection of ecclesiastical laws, which, though very ancient, were not left us by the apostles. It is true, they were sometimes called apostolic canons; but this means no more than that they were made by bishops, who lived soon after the apostles, and were called apostolical men. They consist of regulations, which agree with the discipline of the second and third centuries: the Greeks generally count eighty-five, but the Latins receive only fifty, nor do they observe all these.

CANONICAL, something belonging to, or partaking of, the nature of a canon: thus we read of canonical obedience, which is that paid by the inferior clergy to their superiors, agreeably to the canon law.

CANOPUS, in astronomy, a star of the first magnitude in the rudder of Argo, a constellation of the southern hemisphere.

CANSIERA, in botany, a genus of the Tetrandria Monogynia class and order. Calyx ventricose, four-toothed; no corolla; nectary four-leaved, surrounding the base of the germ; berry one-celled, one-seeded, superior. One species, C. scandens, native of India.

CANTATA, in music, a song or composition, intermixed with recitatives, airs, and different movements, chiefly intended for a single voice, with a thorough base, though sometimes for other instruments. The cantata, when performed with judgment, has something in it very agreeable; the variety of the movements not clogging the ear, like other compositions. It was first used in Italy, then in France, whence it passed to us.

CANTEEN, a small vessel made of tinplate or wood, in which soldiers, when on their march, or in the field, carry their liquor. They are cylindrical, like barrels $7\frac{1}{2}$ inches diameter, and about four inches deep, holding three pints.

CANTHARIDES, in the Materia Medica, are insects used to raise blisters. They differ in their size, shape, and colour; the largest are about an inch long. Some are of a pure azure colour, others of that of pure gold, and others again have a mixture of gold and azure colours, all brilliant and extremely beautiful. These insects are more common in hot countries, though they are occasionally to be met with in all parts of Europe, at some seasons of the year; particularly among wheat and on meadows, upon the leaves of the ash, the poplar, the willow, &c. Such numbers of these insects are sometimes together in the air, that they appear like swarms of bees; they have likewise a very disagreeable smell, which is a guide for those who make it their business to catch them. Those who collect them, tie them in a bag or piece of linen cloth, that has been well worn, upon which they are killed with the vapours of hot vinegar, and dried in the sun, and kept in boxes. When dried, they are so light, that fifty of them will scarcely weigh a dram. The Sicilian cantharides, and particularly those of Etna, are reckoned better than those of Spain. See MATERIA MEDICA and PHARMACY.

CANTHARIS, in natural history, a genus of insects of the order Coleoptera. Generic character; antennæ filiform; thorax mostly margined, shorter than the head; shells flexile; sides of the abdomen edged with folded papillæ. There are more than a hundred species enumerated, which are separated into three divisions; A. four feelers, hatchet-shaped: B. feelers filiform, the last joint setaceous: C. fore-feelers projecting, the last joint but one with a large ovate cleft appendage, the last joint ovate, acute. This division is denominated Lymexylon. The whole genus, excepting the last division, which in the grub and perfect state feeds on green wood, is most rapacious, preying on other insects, and even on its own tribe: C. bipustulata is a very beautiful insect, of a slender and cylindric shape; its colour is a very dark, but elegant, gilded green, with the tips of the wing-shells red, and on each side the thorax, a little below the setting on the wing-shells, is a triple vesicle, of a bright-red colour, extensile or retractile at the pleasure of the insect, and which, if accurately examined by the microscope, will generally be found to exhibit an alternate inflation and contraction, resembling that of the lungs in the larger animals. This species is found during the summer on various plants, and particularly on nettles.

CANTHIUM, in botany, a genus of the Tetrandria Monogynia class and order. Calyx four-toothed, superior; coralla one-pe-

talled, with a short inflated tube, and four-parted border; the mouth downy; drupe two-celled, with a one-celled nut in each. One species, C. parviflorum, found in Coromandel.

CANTICLES, or the *Song of Songs*, in biblical history, a Hebrew mode of expression, to denote a song superlatively excellent in stile and sentiment. Of this ancient poem the author is asserted, by the unanimous voice of antiquity, to have been Solomon; and this tradition is corroborated by many internal marks of authenticity. In the very first verse it is said to belong to Solomon: he is the subject of the piece, and the principal actor in the conduct of it. Though the Song of Songs comes down to us recommended by the voice of antiquity, its divine authority has been called in question by many writers in modern days. Whiston thinks it a dissolute loose song, composed by Solomon when advanced in years, and degenerate in practice; and that therefore it ought to be excluded from the canon of the sacred books. Taken indeed in its primary and literal sense, it must be considered as describing a royal marriage, and may therefore be denominated an epithalamium, or hymeneal song. The celebrated Michaelis supposed that the object of it was to teach God's approbation of marriage. But the ideas of Harmer appear much more rational; who, though unwilling to give it the name of epithalamium, thinks it a marriage song, to be explained by compositions of a similar nature in eastern countries. "What can be more likely," says he, "to lead us into the literal sense of an ancient nuptial poem, than the comparing it with similar modern productions of the East, along with antique Jewish compositions of the same kind?" Bossuet, Bishop of Meaux, was of opinion that this song was to be explained by the consideration, that the Jews were wont to celebrate their nuptials for seven days together, distinguished from each other by different solemnities; and this notion has been adopted by the author of "A new Translation of Solomon's Songs, with a Commentary and Annotations." The principal objection to this opinion is, that the conduct of the poem does not admit of such a distribution; and the distinguishing each day by some distinct ceremony is a mere supposition unsupported by fact. The elegant and learned Bishop Lowth devotes two of his Prælectiones to an examination of this poem, and he determines it, with Bossuet, to be a sacred drama, though deficient in some of the essential requisites of dramatic composition. Sir W. Jones, from his knowledge of Eastern poetry, was led to compare some parts of it with similar productions among the Arabians, and delivers it as his opinion, that it is to be classed with the Hebrew idyls.

Supported by the high authority of this illustrious scholar, Mr. M. Good, in an elegant metrical version with which he has favoured the public, considers the Song of Songs as forming not one continued and individual poem, but a series of poems, each distinct and independent of the other; and he denominates them sacred idyls. "The Song of Songs," he says, "cannot be one connected epithalamium, since the transitions are too abrupt for the wildest flights of the Oriental Muse, and evidently imply a variety of openings and transitions; while, as a regular drama, it is deficient in every requisite that could give it such a classification." It has been also regarded as a parable in the form of a drama, in proof of which, we are told: First, when closely examined, it will appear to possess all the essential qualities of a drama. The marriage of Solomon with the daughter of Pharaoh, (as related 1 Kings i. 1,) a political event which, from the personages concerned in it, would be interesting to the Jewish nation, was, as such, proper to furnish the fable of it. The writer is entirely left behind the curtain, and the whole of the composition is brought forward before the reader in parts between the speakers. The *dramatis personæ* are Solomon, the bride, her attendants, and the virgins of Jerusalem. It should be observed, though the fact has indeed been overlooked by the critics, that all advance is made by the lady herself. She comes to his palace unfetched, and apparently unsolicited. Finding him not there, she goes in search of him, intreats to be received into his embrace; and when, without denying, he eludes her intreaties, she pursues him in the ardour of her affection almost beyond the bounds of female delicacy and modesty. On the contrary, the royal spouse is cold at heart, and distant, prone to recede, and to intrigue with his favourite concubines, but anxious to conceal his indifference and infidelity under laboured encomiums on the beauty of his spouse. The action is complete, possessing a beginning, a middle, and an end, and composed of scenes, the shifting of which, if observed by a modern reader, as by an ancient spectator, would have preserved the

conduct of the piece uniform and consistent. The plot, it must be allowed, is very simple, the intricacies of it arising only from those unforeseen impediments which were thrown by rival beauties in the way of the royal bride, and which threatened to deprive her of the object of her attachment. The catastrophe is the triumph of honourable love over the allurements of seduction, and the security of virtuous enjoyment over the torments of jealousy and illicit fruition. Secondly, considered as a parable; like other parables, while it conveys a literal sense interesting and appropriate, it conveys likewise a religious lesson of supreme importance. Now the method of decyphering a fable or parable is, not by seeking under the veil of the allegory certain maxims of recondite wisdom, which bear no resemblance to the literal sense, but by facts generally known and fully understood: nor is the interpretation to be deemed true, unless, as in the case of the parable of Nathan, or that of the sower, there subsists an obvious and characteristic analogy between the simple and the metaphorical acceptation. On this principle, it is apprehended that, in the parable of the Canticles, the bride means the Jewish religion, and the royal spouse the Jewish nation, represented under the name and person of their ruler and chief; and the object of it is to delineate, under images borrowed from the connubial state, the conduct of the Israelites at large, and that of Solomon in particular, in respect of their knowledge and worship of Jehovah. In proof of this position, it would be necessary to enter farther into the subject than our limits will allow: the reader is therefore referred, for a justification of this theory, to Rees's New Cyclopedia.

CANTO, in music, the treble, or, at least, the higher part of a piece.

CANTON (John), in biography, an ingenious natural philosopher, was born at Stroud, in Gloucestershire, in 1718; and was placed, when young, under the care of Mr. Davis, an able mathematician of that place, with whom he had learned both vulgar and decimal arithmetic before he was quite nine years of age. He next proceeded to the higher parts of the mathematics, and particularly to algebra and astronomy, in which he had made a considerable progress when his father took him from school, and set him to learn his own business, which was that of a broad-cloth weaver. All his leisure time was devoted to the assiduous cultivation of astronomical science; by which he was soon able to calculate eclipses, and to construct various kinds of sun-dials, even at times when he ought to have slept, being done without the knowledge and consent of his father, who feared that such studies might injure his health. It was during this prohibition, and at these hours, that he computed, and cut upon stone, with no better an instrument than a common knife, the lines of a large upright sun-dial, on which, beside the hour of the day, were shewn the sun's rising, his place in the ecliptic, and some other particulars. When this was finished, and made known to his father, he permitted it to be placed against the front of his house, where it excited the admiration of several neighbouring gentlemen, and introduced young Canton to their acquaintance, which was followed by the offer of the use of their libraries. In the library of one of these gentlemen he found Martin's Philosophical Grammar, which was the first book that gave him a taste for natural philosophy. In the possession of another gentleman he saw a pair of globes; a circumstance that afforded him great pleasure, from the great ease with which he could resolve those problems that he had hitherto been accustomed to compute.

Among other persons with whom he became acquainted in early life was Dr. Henry Miles, of Tooting, who perceiving that young Canton possessed abilities too promising to be confined within the narrow limits of a country town, prevailed on his father to permit him to come up to London. Accordingly he arrived at the metropolis the 4th of March 1737, and resided with Dr. Miles at Tooting till the 6th of May following, when he articled himself, for the term of five years, as a clerk to Mr. Samuel Watkins, master of the academy in Spital Square. In this situation his ingenuity, diligence, and prudence, were so distinguished, that on the expiration of his clerkship, in May, 1742, he was taken into partnership with Mr. Watkins for three years; which gentleman he afterwards succeeded in the school, and there continued during the remainder of his life.

Towards the end of 1745, electricity received a great improvement by the discovery of the famous Leyden phial. This event turned the thoughts of most of the philosophers of Europe to that branch of natural philosophy; and our author, who was one of the first to repeat and to pursue the experiment, found his endeavours rewarded by many notable discoveries. Towards the

end of 1749, he was engaged with his friend, the late ingenious Benjamin Robins, in making experiments to determine the height to which rockets may be made to ascend, and at what distance their light may be seen. In 1750 was read at the Royal Society, Mr. Canton's "Method of making Artificial Magnets, without the use of, and yet far superior to, any natural ones." This paper procured him the honour of being elected a member of the Society, and the present of their gold medal. The same year he was complimented with the degree of A. M. by the University of Aberdeen. And in 1751 he was chosen one of the council of the Royal Society; an honour which was twice repeated afterwards.

In 1752, Mr. Canton was so fortunate as to be the first person in England who, by attracting the electric fire from the clouds during a thunder-storm, verified Dr. Franklin's hypothesis of the similarity of lightning and electricity. Next year his paper, entitled "Electrical Experiments, with an Attempt to account for their several Phenomena," was read at the Royal Society. In the same paper Mr. Canton mentioned his having discovered, by many experiments, that some clouds were in a positive, and some in a negative state of electricity: a discovery which was also made by Dr. Franklin in America much about the same time. This circumstance, together with our author's constant defence of the doctor's hypothesis, induced that excellent philosopher, on his arrival in England, to pay Mr. Canton a visit, and gave rise to a friendship which ever after continued between them. Mr. Canton was a contributor to the Philosophical Transactions, and among many other papers, he sent, in 1765, an account of the transit of Venus of the 6th of June that year, observed in Spital Square. On the 16th of December, the same year, another curious addition was made by him to philosophical knowledge, in a paper, entitled, "Experiments to prove that Water is not incompressible." And on Nov. 8, the year following, were read before the Society, his farther "Experiments and Observations on the Compressibility of Water, and some other Fluids." These experiments are a complete refutation of the famous Florentine experiment, which so many philosophers have mentioned as a proof of the incompressibility of water. For this communication he had a second time the Society's prize gold medal. Mr. Canton was a contributor to many other publications, particularly to the Gentleman's Magazine. In every period of his life he was an ardent promoter of useful science; and while philosophy lives the name of Canton will not be forgotten. He died of the dropsy in his 54th year, on the 22d of March, 1772.

CANTONING, in the military art, is the allotting distinct and separate quarters to each regiment of an army; the town where they are quartered being divided into so many cantons, or divisions, as there are regiments.

CANTUA, in botany, a genus of the Pentandria Monogynia class and order. Calyx three to five-cleft; corolla funnel-form; stigma three-cleft; capsule three-celled, three-valved, many-seeded; seeds winged. There are four species, natives of America.

CANVASS, in commerce, a very clear unbleached cloth of hemp, or flax, wove very regularly in little squares. It is used for working tapestry with the needle, by passing the threads of gold, silver, silk, or wool, through the intervals or squares. This also is the name of a coarse cloth of hemp, unbleached, somewhat clear, which serves to cover women's stays, also to stiffen men's clothes, and to make some other of their wearing apparel, &c. It is likewise the name of a very coarse cloth made of hemp, unbleached, serving to make towels, and answering other domestic purposes. It is also used to make sails for shipping, &c.

CAOUTCHOUC, or, as it is usually, though improperly named, *elastic gum*, is a vegetable matter, which in several of its physical qualities, as well as in its chemical relations, has some similarity to vegetable gluten, and which so far agrees both with it and albumen, as to approach in the nature of its composition to animal matter.

The substance to which the name of caoutchouc, or elastic gum, has been more particularly given, was brought from Spanish America, in the form of hollow spheres or bottles, in which state it is still imported into Europe; it was evident, therefore, that it had undergone some artificial preparation. Condamine gave the information, that it is the inspissated juice of a tree belonging to the family of the Euphorbia, which has since received the botanical name of Havea guianensis, or Havea caoutchouc. Incisions are made in the bark of this tree: a milky juice exudes, which is collected. It is applied in successive coatings over a mould of clay; is dried up by exposure to the sun, and afterwards by being placed in the smoke

from burning fuel; when dry, the clay mould is crushed, and the fragments extracted, and in this manner the spherical bottles are formed. It has since been discovered, that caoutchouc is not exclusively the produce of this vegetable; but that it is furnished likewise by other plants, either perfectly the same, or with very slight variations of properties. It is obtained in large quantity from the Jatropha elastica, a native likewise of different provinces of South America. Fourcroy procured specimens of the juice of the caoutchouc in the state in which it exists previous to its inspissation, from the island of Bourbon, from Cayenne, and the Brazils, and examined its properties. From experiments he concluded, that caoutchouc exists ready formed in the juice of the tree, and is capable of being separated in the concrete form; but that a portion also exists not sufficiently perfect to be deposited with its elastic property; that it acquires this, together with its inspissation, from the action of oxygen; and that by this operation, exposure to the atmosphere influences the concretion of caoutchouc in the usual process in which it is brought to the solid form.

The purest caoutchouc Fourcroy supposes to be that which separates spontaneously from the juice in close vessels. It is white, or of a slight fawn colour. The properties of caoutchouc have been determined principally from the state in which it exists in the elastic bottles which are imported to Europe; and in this state its properties do not seem to have undergone any important change, or to be different from those of the pure caoutchouc. Its colour is a dark brown; its external surface is smooth; its internal texture is rough, and presents a fibrous appearance. Its specific gravity is nearly the same with water, being from 9.3 to 10.0. It is inodorous, and is also destitute of taste.

The most remarkable physical property of which this substance is possessed, and which eminently distinguishes it, is its high elasticity. It can be stretched out to a great length, and when the force that has been applied to it is withdrawn, it instantly returns to its former dimensions. Its pliancy is increased by heat, while it is rendered more rigid by cold; and its softness, which is connected with the former quality, is so much increased by warmth, that it can be moulded into any form, and two parts newly cut may even be pressed together, so as to be intimately united.

Caoutchouc, exposed in a dry state to a high temperature, softens, swells up, and emits a fetid odour similar to that of animal substances: as the heat is increased, it melts into a viscid matter, and remains in this state when cold. If heated sufficiently high it takes fire, and burns with a vivid light and dense smoke: in the countries in which it is produced it has been used for torches. It is perfectly insoluble in water and alcohol, but is dissolved in ether.

This substance is capable of being applied to important purposes, from its softness and flexibility, its elasticity, and particularly its indestructibility, and not being affected by air, water, or indeed the greater number of chemical agents. Tubes for conveying gases, and other chemical instruments, are accordingly prepared from it; and bougies, catheters, and similar surgical instruments of caoutchouc, are much preferable to what can be prepared from any other substance.

The solution of caoutchouc in some of the oils has been used as a varnish, to render flexible substances, as silk, &c. impermeable to water or air. It has the advantage of being perfectly flexible; but it is long before it dries, and is liable to be softened by a very moderate heat. To render it less viscid, it is generally prepared from a mixture of volatile and expressed oils.

CAP *of maintenance*, one of the regalia, or ornaments of state, belonging to the kings of England, before whom it was carried at the coronation, and other great solemnities. Caps of maintenance are also carried before the mayors of several cities in England.

It is of crimson velvet, faced with ermine, and was formerly esteemed a badge and symbol of dignity, and suitable to a prince of the blood, being worn by King Edward III. and succeeding sovereigns down to Edward VI.; but of late it has been granted to private families. It is frequently to be met with above the helmet, instead of a wreath, under gentlemen's crests.

Cap, in a ship, a square piece of timber put over the head or upper end of any mast, having a round hole to receive the mast. By means of these caps the top-masts and top-gallant-masts are kept steady and firm in the tressel-trees where their feet stand.

Cap *of a gun*, a piece of lead which is put over a touch-hole of a gun to keep the priming from being wasted or spoiled.

CAPACITY, in a general sense, an aptitude or disposition to retain or hold any thing.

Capacity, in geometry, is the solid contents of any body; also our hollow measures

for wine, beer, corn, salt, &c. are called measures of capacity.

Capacity, in the modern doctrine of heat, signifies the proportional capability of a given quantity of any substance to absorb and retain caloric, or that disposition or property by which various bodies respectively require more or less of this fluid to superinduce any given temperature in a given mass. See Caloric.

That this capacity varies in different bodies, and even in the same substance in different states, may be easily shewn. If the quantities of heat necessary to be added to or taken from bodies, in order to produce equal changes in their temperature, were in all cases proportional to their respective quantities of matter;—as if, for example, it would require the same quantity of this fluid to heat a pound of water, a pound of oil, or a pound of mercury 20 degrees; this would, of course, indicate that their capacities were equal: but if, on the contrary, it should be found that the same quantity of caloric applied to these various substances, should produce different changes in the temperature of equal quantities, or equal changes in the temperature of different quantities of each, it would follow, that their capacities for this fluid must proportionally vary. Let us conceive, that having three several pounds of water at the temperature of 110° of Fahrenheit's thermometer in separate vessels, there be added to the first a quantity of water at 50°; to the second a quantity of spermaceti oil, also at 50°; and to the third a quantity of mercury at the like temperature of 50°; and that each of the mixtures be stirred together, and the addition continued, till they have all assumed throughout a common temperature of 70°. Now, as each of the pounds of water has, in this case, been deprived of an equal quantity of caloric, (*viz.* as much as was necessary to raise its temperature 40°, or from 70° to 110°, the absolute capacities of the whole of the water, the oil, and the mercury, which have been added, must, of course, be equal, whatever be the quantity of each; each of them having absorbed an equal quantity of heat. On comparing the quantities of these latter substances, however, it will be found that we have employed in the experiment about 2 pounds of water at 50°, 4 pounds of oil, and nearly 60 pounds of mercury, each of which has been heated 20°; so that it requires as much caloric to heat one pound of water 20°, as to produce the same effect on two of oil, or 30 of mercury; and their relative capacities are therefore inversely in this proportion. A change of capacity in the same body is producible in three ways: by mechanical compression or dilatation, by chemical combination, or by the action of heat itself, of each of which we shall say a few words. With regard to the first, the general fact appears to be, that wherever a body is by any means condensed, its capacity becomes diminished, but that where it is dilated or enlarged in its bulk, it is proportionally increased. Thus, if a thermometer be suspended in a receiver, and a quantity of air condensed into it, the mercury will rise; a part of the caloric which is contained in the air being, as it were, squeezed out by its compression, and forced into the mercury in the bulb, whose temperature is consequently raised: if, however, on the contrary, the air be rarified, the thermometer will indicate cold; the capacity of the air in the receiver being increased by its rarefaction, and a portion of the caloric in the contiguous bodies consequently absorbed, whereby their temperature is lowered and their bulk diminished.

The second mode of changing the capacities of bodies is by their chemical combination; and, perhaps, there is no combination unaccompanied by such a change. In some instances this takes place in a very remarkable degree, and it is from hence that we derive the effects of calorific and frigorific mixtures. If, for example, a quantity of sulphuric acid, diluted with an equal measure of water, be poured on a quantity of crystals of Glauber's salt, recently powdered, the capacity of the compound is considerably greater than that of its component ingredients; it becomes, therefore, strongly absorbent of caloric, which it attracts from the bodies in its vicinity, and a quantity of water in a phial placed in the mixture will be soon frozen.

The third case of change of capacity, by the action of heat itself, is, perhaps, productive of more important effects in nature than either of the other two. The capacities of all bodies are increased in some proportion to the dilatation of their bulk, and the disaggregation of their constituent particles, as well by the agency of caloric as by any other cause. Hence, when a solid is fused, or a liquid resolved into vapour, cold is produced by the augmentation of its capacity; and, *e converso*, when steam is condensed, or congelation takes place, heat

is developed by its diminution. Thus, if equal quantities of pounded ice and water, each at 32° of Fahrenheit, be exposed to heat in two similar vessels in a water-bath, the water will be heated to 178° before the ice is all dissolved, the water produced from which will, of course, still remain at 32°, so that the increase of capacity in the ice, during its solution, is sufficient to enable it to absorb, without any elevation of its temperature, as much caloric as has raised the temperature of an equal quantity of water 146°; and the like quantity is also again emitted on its becoming again congealed. If a quantity of water be exposed without agitation to a degree of cold equal to 24° or 25°, it will frequently acquire this temperature without freezing; but as soon as congelation begins, the thermometer will immediately rise to 32°, and the whole will remain at that temperature till all the water is converted into ice.

This latter change of capacity appears to be absolutely essential to the well-being of the universe, as affording a constant modification of the action of heat and cold, whose effects would otherwise be inordinate. If this did not take place, the whole of a mass of water which was exposed to a temperature above the boiling point would be instantly dissipated in vapour with explosion. The fact, however, is, that the capacity of those portions of the liquid which are successively resolved into a vapour becomes thereby sufficiently augmented to enable them to absorb the superabundant caloric as fast as it is communicated: and it is for this reason that boiling water in an open vessel never reaches a higher temperature than 212°. The polar ices would all instantaneously dissolve, whenever the temperature of the circumambient air was above 32°, if it were not that each particle absorbs a quantity of caloric in its solution, and thereby generates a degree of cold which arrests and regulates the progress of the thaw; and the converse of this takes place in congelation, which is in its turn moderated by the heat developed in consequence of the diminution of capacity, which takes place in the water during its transition to a solid state.

Capacity, in law, the ability of a man, or body politic, to give or take lands, or other things, or sue actions.

Our law allows the king two capacities, a natural and a political; in the first he may purchase lands to him and his heirs; in the latter to him and his successors. The clergy have the like.

CAPARASON, or horse-cloth, a sort of cover for a horse. For led horses it is commonly made of linen cloth, bordered round with woollen, and enriched with the arms of the master upon the middle, which covers the croupe, and with two ciphers on the two sides. The caparasons for the army are sometimes a great bear's skin, and those for stables are of single buckram in summer, and of cloth in the winter.

CAPELLA, in astronomy, a bright fixed star of the first magnitude, in the left shoulder of the constellation Auriga. It is in the Britannic Catalogue the fourteenth in order of that constellation. Its longitude is 17° 31′ 41″, its latitude 22° 51′ 47″.

CAPER. See Capparis.

CAPIAS, is a writ of two sorts, one whereof is called *capias ad respondendum*, before judgment, where an original is sued out, &c. to take the defendant and make him answer the plaintiff: and the other a writ of execution, after judgment, being of divers kinds.

Capias *ad respondendum*, is a writ commanding the sheriff to take the body of the defendant, if he may be found in his bailiwic or county, and him safely to keep, so that he may have him in court on the day of the return to answer to the plaintiff of a plea of debt, or trespass, or the like, as the case may be. And if the sheriff return that he cannot be found, then there issues another writ, called an *alias capias*; and after that another, called *pluries capias*; and if upon none of these he can be found, then he may be proceeded against unto outlawry. But all this being only to compel an appearance, after the defendant hath appeared, the effect of these writs is taken off, and the defendant shall be put to answer, unless it can be in cases where special bail is required, and there the defendant is actually to be taken into custody.

Capias *ad satisfaciendum*, is a writ, directed to the sheriff, commanding him to take the body of the defendant and him safely to keep, so that he may have his body in court at the return of the writ, to make the plaintiff satisfaction for his demand; otherwise he is to remain in custody till he do. When a man is once taken in execution upon this writ no other process can be sued out against his lands or goods. But if a defendant die whilst charged in execution upon this writ, the plaintiff may, after his death, sue out new executions against his lands, goods, or chattles.

Capias *utlegatum*, is a writ that lies

against a person that is outlawed in any action, whereby the sheriff is commanded to apprehend the body of the party outlawed, and keep him in safe custody till the day of the return of the writ, and then present him to the court, there to be dealt with for his contempt. But this being only for want of appearance, if he shall afterwards appear the outlawry is most commonly reversed.

Capias *in withernam*, is a writ directed to the sheriff, in case where a distress is carried out of the county, or concealed by the distrainer, so that the sheriff cannot make deliverance of the goods upon a replevin, commanding him to take so many of the distrainer's own goods, by way of reprisal, instead of the other that are so concealed.

CAPILLARY *tubes*, in physics, little pipes, whose canals are extremely narrow, their diameter being only a half, third, or fourth of a line.

The ascent of water, &c. in capillary tubes is a phenomenon that has long embarrassed philosophers; for let one end of a glass tube, open at both ends, be immerged in water, and the liquor within the tube will rise to some sensible height above the external surface: or if two or more tubes are immerged in the same fluid, one of them a capillary one, the other of a large bore, the fluid will ascend higher in the capillary tube than in the other, and this in the reciprocal ratio of the diameters of the tubes.

In order to account for this phenomenon, it will be necessary first to premise that there is a greater attraction between the particles of glass and water than there is between the particles of water themselves: this appears plain from experience, which proves the attractive power in the surface of glass to be very strong; whence it is easy to conceive how sensibly such a power must act on the surface of a fluid, not viscid as water, contained within the small cavity or bore of a glass tube; as also that it will be in proportion stronger as the diameter of the bore is smaller; for that the efficacy of the power follows the inverse proportion of the diameter is evident from hence, that only such particles as are in contact with the fluid, and these immediately above the surface, can affect it. Now these particles form a periphery contiguous to the surface, the upper part of which attracts and raises the surface, and the lower part, which is in contact with it, supports and holds it up, so that neither the thickness nor length of the tube avails any thing, only the said periphery of particles, which is always proportional to the diameter of the bore: the quantity of the fluid raised will therefore be as the surface of the bore which it fills, that is, as the diameter; as the effect would not be otherwise proportional to the cause, since the quantities follow the ratio of the diameters, the heights to which the fluids will rise in different tubes will be inversely as the diameters.

Some, however, doubt whether the law holds throughout, of the ascent of the fluid being always higher as the tube is smaller. Dr. Hook's experiments, with tubes almost as fine as cobwebs, seem to shew the contrary. The water in these, he observes, did not rise so high as one would have expected. The highest he ever found was at 21 inches above the level of the water in the bason, which is much short of what it ought to have been by the law above-mentioned.

Capillary *vessels*, in anatomy, the smallest and extreme parts of the veins and arteries.

CAPITAL, the head, chief, or principal of a thing. Thus,

Capital, in geography, denotes the principal city of a kingdom, province, or state; as London is the capital of Britain.

Capital, among merchants, traders, and bankers, signifies the sum of money which individuals bring to make up the common stock of a partnership when it is first formed. It is also said of the stock which a merchant at first puts into trade for his account. It signifies likewise the fund of a trading company, or corporation, in which sense the word stock is generally added to it: thus, we say, the capital stock of the bank, &c. The word capital is opposed to that of profit or gain, though the profit often increases the capital, and becomes itself a part of it.

Capital *crime*, such a one as subjects the criminal to capital punishment, that is, the loss of life.

Capital, in architecture, the uppermost part of a column or pilaster, serving as the head or crowning, and placed immediately over the shaft, and under the entablature.

The capital is the principal part of an order of columns or pilasters. It is of a different form in the different orders, and is that which chiefly distinguishes and characterizes the orders. Such of these as have no ornaments, as the Tuscan and Doric, are called capitals of mouldings; and the rest,

which have leaves and other ornaments, capitals of sculptures.

CAPITAL, *Tuscan*, consists of three members, *viz.* an abacus, under this an ovolo or quarter round, and under that a neck or colarino, terminating in an astragal or fillet, belonging to the shaft.

It is the most simple and unadorned of all capitals; and the character which distinguishes it from the Doric, is that the abacus is square, and quite plain without moulding.

CAPITAL, *Doric*, has its abacus crowned with a talon and three annullets under the ovolo.

CAPITAL, *Ionic*, that which is distinguished by volutes and ovolos. The ovolo is adorned with eggs, as they are sometimes called from their oval form.

CAPITAL, *Corinthian*, is the richest of all, being adorned with a double row of leaves, with eight large and as many small volutes, situated round a body, which by some is called campana, or bell, and by others tambour.

CAPITAL, *composite*, that which has the double row of leaves of the Corinthian, and the volutes of Ionic capital.

CAPITALS, among printers, large or initial letters, in which titles are composed.

The English printers some years ago made it a rule to begin almost every substantive with a capital; a custom not more absurd than that of using no capitals at all.

Capitals, however, may very properly commence the first word of every book, chapter, letter, note, or any other piece of writing: the first word after a period, and, if the two sentences are totally independent, after a note of interrogation or exclamation; but if a number of interrogative or exclamatory sentences are thrown into one general group, or if the construction of the latter sentences depends on the former, all of them, except the first, may begin with a small letter: the appellations of the Deity: proper names of persons, places, streets, mountains, rivers, ships: adjectives derived from the proper names of places: the first word of a quotation, introduced after a colon, or when it is in a direct form; but when a quotation is introduced obliquely after a comma, a capital is unnecessary: the first word of an example: every substantive and principal word in the titles of books: and the first word of every line in poetry. The pronoun I, and the interjection O, are also written in capitals. Other words, beside the preceding, may likewise begin with capitals, when they are remarkably emphatical, or the principal subject of the composition. The ancient MSS. both Greek and Latin, are written wholly in capitals.

CAPITATION, a tax or imposition raised on each person in consideration of his labour, industry, office, rank, &c.

CAPITE, in law, an ancient tenure of land, which was held immediately of the king, as of his crown, either by knight's service or socage. The tenure in capite was of two kinds, the one principal and general, the other special or subaltern. The former was of the king, the fountain from whence all tenures have their main original. The latter was of a particular subject, so called because he was the first that granted the land in such manner, and hence he was styled "capitalis dominus, and caput terræ illius." This tenure is now abolished, and, with others, turned into common socage.

CAPITULATION, in military affairs, a treaty made between the garrison or inhabitants of a place besieged, and the besiegers, for the delivering up the place on certain conditions.

The most honourable and ordinary terms of capitulation are, to march out at the breach, with arms and baggage, drums beating, colours flying, a match lighted at both ends, and some pieces of cannon, waggons, and convoys for their baggage, and for the sick and wounded.

CAPPARIS, in botany, English *caper-bush*, a genus of the Polyandria Monogynia class and order. Natural order of Putamineæ. Capparides, Jussieu: Essential character: calyx four-leaved, coriaceous; petals four; stamens long; berry corticose, one-celled, pedicelled. There are twenty-five species. This genus consists of shrubs. The leaves are simple, in the berry-bearing sorts having frequently two spines at the base, but in those which bear pods commonly naked or bi-glandular. Flowers in a kind of corymb, terminating. Some of the species have a berry, others have a silique or pod for a fruit. C. spinosa, common caper-bush, is a low shrub, generally growing out of the joints of old walls, the fissures of rocks, and among rubbish. It grows wild in the southern countries of Europe, and in the Levant. Dr. Smith thinks it surprising that this beautiful shrub, which is as common in the south of France as the bramble with us, should be almost unknown

in our gardens, where it can scarcely be made to flower, except in a stove with great care.

CAPRA, the goat, in natural history, a genus of Mammalia of the order Pecora. Generic character: horns hollow, compressed; rough, almost close at their base, turned back; eight lower fore teeth; no tusks; chin in the male bearded. Of these there are three species, of which we shall attend particularly to the C. hircus, or common goat. This animal is found domesticated in almost every part of the globe, but was introduced into America, only on its discovery by Europeans. In its internal structure it extremely resembles sheep, but is far superior to them in alertness, sentiment, and intelligence. The goat approaches man without difficulty, is won by kindness, and capable of attachment. Confinement is ill suited to his excursive tendencies, and he is fond of retiring into solitude, and ranging on the cliffs of the most rugged and barren mountains. He will not only climb and stand on the loftiest craggs, but sleep also on the verge of the most steep and terrific precipices. He is capable of enduring both cold and heat, and the most ardent rays of the sun produce in him no vertigo or sickness of any description, the violence of storms causes him little or no inconveniences, but he suffers somewhat from very rigorous cold. His organs are extremely supple, and his frame is robust and nervous. Almost all herbs are used by him for food, and few are noxious to him. His favourite nourishment, however, is derived from the tender branches and bark of trees and shrubs, from lichens and hemlock. He is sprightly, roaming, and lascivious in the extreme; inconstant, and capricious in his temper; and the vivacity of his feelings is exhibited in a perpetual succession of rapid, abrupt, and sportive movements. He prefers barren heaths to luxuriant pastures, avoids moist and marshy places, and never flourishes but in mountainous, or at least elevated situations. The female will allow itself to be sucked by the young of various other animals, and a foal which has lost its mother, has been seen thus nourished by a goat, which in order to facilitate the process was placed on a barrel. The attachment between the nurse and foal appeared strong and natural. The milk of the goat, containing few oily particles, is much valued in medicine, and being easily crudled, is formed into cheese of high estimation. The celebrated Parmesan cheese is made of it.

The goats of Wales are generally white, and are both stronger and larger than those of other hilly countries. Their flesh is much used by the inhabitants, and often dried and salted, and substituted for bacon. The skins of kids are much valued for gloves, and were formerly employed in furniture, when painted with rich colours, of which they are particularly capable, and embellished with ornamental flowers and works of silver and gold.

The extremely unpleasant odour attending these animals is supposed to be beneficial, and horses appear so much refreshed by it, that a goat is on this account often kept in the stables of the great. Of the many varieties of this species, that of Angora is the most curious. It is principally valued for its long and exquisitely fine hair, which it loses by a change of pasture from the immediate vicinity of Angora, and which the owners are incessantly assiduous in washing and combing, and otherwise promoting its growth and cleanliness. It is formed into camlets of the finest texture.

The Syrian goat is remarkable for its pendulous ears, and is common in various parts of the East: the animals of this variety are driven in flocks through the Oriental towns every morning and evening, and each housekeeper sees drawn from them, before her door, as much milk as she is in want of. See Mammalia, Plate VI. fig. 6.

The Chamois goat inhabits the most elevated mountains of Europe, and feeds on shrubs, roots, and herbs: its chase is extremely laborious and dangerous: its sight and smell are both exquisite: it is particularly shy: its swiftness is also very great, and it makes its way with speed over the most pointed rocks, can mount or descend precipices with facility, and hang on steeps nearly perpendicular. Plate VI. fig. 5.

C. Ibex, or the Ibex goat of Pennant. This is considerably larger than the last species: its blood was formerly deemed a specific in the materia medica for various diseases: its strength and feeling are extraordinary: it is found in the Carpathian and Pyrennean mountains, in the Rhœtian Alps, in Crete, and in Tartary, When hardly pressed it will throw itself from a vast height with little or no injury, contriving always to fall on its horns. Plate IV. fig. 4.

Fig. 1. **Canis** *hyæna: striped Hyæna. Fig. 2. C. lupus. Wolf. Fig. 3. C. aureus: Jackal.*
Fig. 4. C. vulpes: Fox. Fig. 5. **Capra** *ægagrus: Chamois goat. Fig. 6. Syrian goat.*

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C. Caucasica, the Caucasan goat, inhabits the most rugged rocks of mount Caucasus, and is, perhaps, superior in vigour and agility to all that have been mentioned. A bezoar is sometimes found in the stomach of this animal as well as in that of several other quadrupeds. Monardes states that he saw one of these creatures leap from a high tower, and having reached the ground upon his horns, immediately, without any wound, dislocation, or contusion, rise on his feet.

CAPRARIA, in botany, *goat-weed*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu: Essential character, calyx five-parted; corol bell-form, five-cleft, acute; capsules bivalve, bilocular, many seeded. There are seven species, of which C. biflora, shrubby goat-weed, or sweet weed, is a shrub seldom exceeding four feet in height; branches long and woody; leaves oblong accuminate at both ends, an inch and half long; peduncles one-flowered, slender; flowers without scent; calyx smooth; corolla white; capsule furrowed on both sides the length of the calyx: seeds small. It is common in Jamaica, in all the Caribbees, and the neighbouring continent.

CAPRICORN, in astronomy, one of the twelve signs of the zodiac, represented on globes in the form of a goat, and characterized in books by this mark ♑. See ASTRONOMY.

CAPRICORN, *tropic of*, a lesser circle of the sphere, which is parallel to the equinoctial, and at 23° 30′ distance from it southwards.

CAPRIFOLIA, the third order of the eleventh class of Jussieu's natural system. It has the following characters: calyx one-leafed, superior, often calycled or bracteated at its base; corolla generally monopetalous, either regular or irregular, in a few instances polypetalous; petals united by a broad base; stamens of a definite number, often five, in the monopetalous genera always inserted into the corolla, and alternating with its segments; in the polypetalous ones sometimes placed upon the pistil, alternating with the petals, and sometimes fixed to the middle of each petal; germ inferior; style generally single, sometimes none; stigma single, or rarely three; fruit inferior, either a berry or a one or many-celled capsule; each cell with one or many seeds; corculum of the seed in a large upper cavity of the large solid perisperm; stem either a shrub or a tree, rarely herbaceous; leaves in most opposite, in a few alternate; stipules none.

CAPRIMULGUS, the *goatsucker*, in natural history, a genus of birds of the order Passeres. Generic character: bill short and hooked at the end; mouth extremely wide, with seven or more stiff bristles on the upper mandible; tongue entire at the end and small; tail of ten feathers, and not forked; legs short; toes united as far as the first joint by a membrane; middle claw with a broad serrate edge.

The birds of this genus, unless disturbed, or in cloudy and gloomy weather, seldom make their appearance by day, but by night are active and alert in the pursuit of insects, which constitute their food. The female deposits only two eggs, and on the bare ground. There are according to Gmelin 19 species, though Latham enumerates only 15. The most curious and interesting are—

C. Europæus, or the European goatsucker. This is the only species met with in Europe, in every part of which it may be found, though no where abundantly, and it is never observed to unite in companies. Being migratory, it arrives in England in May, and quits it in September. It is a mortal enemy to various insects, and particularly to cockchafers, six of which, besides four very large moths, have been found in its stomach. The glare of day is overpowering to its sight, which is clearest by twilight. During this, therefore, it is in quest of food, and in full activity. It is singular for perching, not across a branch, as other birds do, but length-wise: the female lays her eggs on the ground instead of a nest, apparently little anxious for their maturity; though when disturbed she will move them, it is said, to a place imagined by her to be more secure.

C. Virginianus, or the Virginian goatsucker. This bird arrives in Virginia in April, and inhabits principally the mountainous parts of that country. As the evening advances, it approaches the habitations of man, and fixing on a post or rail utters many times one plaintive cry; and from the evening till the morning this movement and cry are with short intervals repeated. Instead of pursuing insects always on the wing, it often leaps up for them as they pass with the most successful dexterity, falling back again upon its perching place. Its flesh is valued for food.

CAPSICUM, in botany, English Guinea-

pepper, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corol rotated; berry exsuccous. There are five species according to Martyn, but many botanists mention sixteen, and others twenty. C. annuum, annual capsicum, or Guinea-pepper, is two feet high, upright, branched, leaves ovate lanceolate, smooth, and of a dark green colour; flowers white, lateral, solitary. The fruit is a berry, varying in size and shape, extremely smooth and shining on the outside, scarlet or yellow. The beauty of the capsicum is in their ripe fruit, forming a pretty contrast to their dark leaves and white flowers, making a beautiful appearance in the gardens when properly disposed, or when planted in pots for the decoration of courts. Most of the sorts of capsicum are natives of both the Indies, but they are chiefly brought to Europe from America, where they abound in all the Caribbee islands, and are greatly used in sauces, whence the fruit is called Guinea-pepper. From the C. minimum is obtained the Cayenne-pepper, so much used in highly-seasoned cookery. See Cayenne-pepper.

CAPSTAN, or *main-capstan*, in a ship, a great piece of timber in the nature of a windlass, placed next behind the mainmast, its foot standing in a step on the lower deck, and its head between the upper deck; formed into several squares with holes in them. Its use is to weigh the anchors, to hoist up or strike down top-masts, to heave any weighty matter, or to strain any rope that requireth a main force.

Capstan-*bars*, the pieces of wood that are put into the capstan holes, to heave up any thing of weight into the ship.

Capstan, *pawl of a*, a short piece of iron made fast to the deck, and resting upon the whelps to keep the capstan from recoiling, which is of dangerous consequence.

Capstan, *whelps of a*, are short pieces of wood made fast to it, to keep the cable from coming too nigh in turning it about.

CAPSULE, among botanists, a species of pericarpium, or seed-vessel, composed of several dry elastic valves, which usually burst open at the points when the seeds are ripe: it differs from a pod in being roundish and short. This kind of pericarpium sometimes contains one cell or cavity, sometimes more: in the first case it is called unilocular, as it is bilocular, trilocular, &c. when it contains two, three, &c. cells or cavities.

CAPTION, in law, is where a commission is executed, and the commissioners subscribe their names to a certificate, declaring when and where the commission was executed. It relates chiefly to commissions, to take answers in chancery, and depositions of witnesses, and take fines of lands, &c.

Caption and *horning*, in the law of Scotland. When a decree or sentence is obtained against any person, the obtainer thereof takes out a writ, whereby the party decerned is charged to pay or fulfil the will of the decree, under the pain of rebellion: this writ is called letters of horning. If he refuse to comply, then the writ or letters of caption may be raised, whereby all the inferior judges and magistrates are commanded to assist in apprehending the rebel, and putting him in prison.

CAPTURE, a prize taken by a ship of war at sea: vessels are looked upon as prizes if they fight under any other standard than that of the state from which they have their commissions if they have no charter-party, invoice, or bill of lading aboard; if loaded with effects belonging to the king's enemies, or even contraband goods. Those of the king's subjects recovered from the enemy after remaining twenty-four hours in their hands are deemed lawful prizes if taken. In ships of war the prizes are to be divided among the captors, *i. e.* officers, seamen, &c. as his Majesty shall appoint by proclamation; but among privateers the division is according to agreement among the owners. See Prize.

CAPURA, in botany, a genus of the Hexandria Monogynia class and order. Essential character; calyx none; corolla six-cleft; stamina within the tube; germ superior; stigma globular; pericarp berry. There is but one species; *viz.* C. purpurata, native of the East Indies.

CAPUT *Draconis*, the *Dragon's head*, in astronomy, the ascending node of the moon. See Node. Caput Draconis is also a star of the first magnitude, in the head of the constellation Draco.

Caput *mortuum*, in chemistry, that thick dry matter which remains after distillation of any thing, but of minerals especially. These residues were formerly thrown away as of no value. Glauber was the first person who examined them with minuteness, and in the research he discovered the sulphate of soda, then named after himself, Glauber's salt. This he obtained in the caput mortuum remaining after the distilla-

tion of muriatic acid from common salt and green vitriol.

CARABINE, a fire-arm, shorter than a musket, carrying a ball of twenty-four in the pound, borne by the light horse, hanging at a belt over the left shoulder. The barrel is two feet and a half long, and is sometimes furrowed spirally within, which is said to add to the range of the piece.

CARABUS, in natural history, a genus of insects of the order Coleoptera. Generic character; antennæ filiform; feelers mostly six; the last joint obtuse and truncate; thorax flat, margined; shells margined. This is an exceedingly numerous genus, and the insects of it are extremely active and quick in running; they devour the larvæ of other insects, and all the weaker animals they can overcome; the legs are long; thighs compressed; shanks rounded and ciliate within, the fore ones spinous before the tip: the larvæ are found under ground, or in decayed wood. Many species are to be found in our own country, among which one of the largest is the C. hortensis, so named from its being frequently seen in gardens and pathways. Among the smaller species is the C. cupreus, a very frequent insect, being seen almost every where during the summer months in gardens, dry pathways, &c. generally running, like the rest of the genus, with a very brisk motion; its usual length is about half an inch, and its colour varying from the copper to the gold green. Of the British species more than a hundred have been enumerated. On the continent the C. crepitans is the most remarkable; so named from the power which it possesses of discharging from behind, several times in succession, on being pursued, a fetid and penetrating vapour, accompanied by a very smart explosion, thus escaping by terrifying its pursuers.

CARACT, CARAT, CARRAT, the name of that weight which expresses the degree of fineness that gold is of. The mint-master, or custom, have fixed the purity of gold at 24 caracts; though it is not possible so to purify and refine that metal, but it will want still about one-fourth part of a caract in absolute purity and perfection. These degrees serve to distinguish the greater or lesser quantity of alloy therein contained: for instance, gold of 22 caracts is that which has two parts of silver, or of any other metal, and 22 of fine gold. The caract is divided into $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, and $\frac{1}{32}$.

CARACT is also a certain weight which goldsmiths and jewellers use wherewith to weigh precious stones and pearls. The caract by which jewellers estimate the weight of diamonds and pearls is about $\frac{1}{150}$ of an ounce troy: hence the caract is about $3\frac{1}{5}$ grains troy.

CARAVAN, in the East, signifies a company or assembly of travellers and pilgrims, and more particularly of merchants, who for their greater security, and in order to assist each other, march in a body through the deserts, and other dangerous places, which are infested with Arabs or robbers. There is a chief, or aga, who commands the caravan, and is attended by a certain number of janizaries, or other militia, according to the countries from whence the caravans set out; which number of soldiers must be sufficient to defend them, and conduct them with safety to the places for which they are designed, and on a day appointed. The caravan encamps every evening near such wells or brooks as their guides are acquainted with; and there is a strict discipline observed upon this occasion, as in armies in time of war. Their beasts of burden are partly horses, but most commonly camels, who are capable of undergoing very great fatigue. The Grand Signior gives one-fourth of the revenues of Egypt to defray the expense of the caravan that goes yearly to Mecca to visit Mahomet's tomb: the devotees in this caravan are from forty to seventy thousand, accompanied with soldiers to protect them from the pillage of the Arabs, and followed by eight or nine thousand camels, laden with all necessary provisions for so long a passage across deserts.

CARAVAN is also used for the voyages or campaigns which the knights of Malta are obliged to make at sea against the Turks and Corsairs, that they may arrive at the commandaries or dignities of the order. The reason of their being thus called, is because the knights have often seized the caravans going from Alexandria to Constantinople.

CARAVANSERA, or KARAVANSERA, a large public building, or inn, appointed for receiving and lodging the caravans. It is commonly a large square building, in the middle of which there is a very spacious court; and under the arches or piazzas that surround it there runs a bank, raised some feet above the ground, where the merchants, and those who travel with them in any capacity, take up their lodgings as well as they can; the beasts of burden being tied to the foot of the bank. Over the gates that lead into the court there are sometimes little

rooms, which the keepers of the caravanseras let out, at a very high price, to such as have a mind to be private. The caravanseras in the East are something in the nature of the inns in Europe, only that you meet with little accommodation either for man or beast, but are obliged to carry almost every thing with you: there is never a caravansera without a well or spring of water. These buildings are chiefly owing to the charity of the Mahometans: they are esteemed sacred dwellings, where it is not permitted to insult any person, or to pillage any of the effects that are deposited there. They even carry their precautions so far, as not to suffer any man who is not married to lodge there; because they are of opinion, that a man who has no wife is more dangerous than another.

CARBON, in chemistry. The term carbon having been understood in different senses, and having been actually applied to different substances, it is necessary to guard against the ambiguity arising from this circumstance, and with this view to trace in a general manner the progress of those discoveries from which the name originated, and by which its application has since been changed.

When vegetable matter, especially the more solid parts of plants, the wood for example, is exposed to heat in close vessels, it is decomposed; the more volatile principles are disengaged, and there remains a black, shining, porous body, composed of the various substances which are not convertible by a high temperature to the gaseous form. This substance is termed charcoal. While the atmospheric air is excluded, it is neither fused nor volatilised by any increase of heat; but when the air is admitted, it suffers combustion, and it continues to burn till nearly the whole of it is consumed; the residuum amounting to not more than the 200th part of the weight of the original charcoal. This residuum is uninflammable, and consists principally of saline and metallic matter. Charcoal then is a heterogeneous substance. By far the greater part of it consists of an inflammable substance which combines with oxygen, and forms the carbonic acid of the modern nomenclature. But this inflammable matter, as it exists in the charcoal, is mixed or combined with the saline and metallic substances left after its combustion. For the sake of precision, a distinction is made in the new nomenclature between the pure inflammable base and the substance in which it is thus presented to us. Charcoal is that black porous substance obtained from vegetable matter, especially from wood, by exposing it to heat; and the pure inflammable substance, which composes by far the greater part of the charcoal, was termed carbon. Carbon, therefore, according to this signification, was charcoal destitute of the small quantity of saline and metallic matter usually mixed with it. The principal advantage of the introduction of the name carbon, was not merely that of distinguishing the inflammable base from the substance in which it was mixed with other ingredients; but also that of giving a term capable of combination, and of affording those derivative appellations which the modern system requires. This substance is not a hypothetical being, since, by certain chemical processes, by the decomposition of carbonic acid for instance, or of alcohol by heat, it is possible to obtain it perfectly pure. It exists in a large quantity as a component part of vegetable substances; it enters into the composition of animal matter, and is contained in substances belonging to the mineral kingdom. This substance, which when it is obtained pure exists in the form of a very light black powder, was, until within these few years, considered as a simple body; but experiments have proved, that it is a compound, containing an inflammable substance, according to some chemists, in a state of imperfect oxydation; according to others, combined with hydrogen. It had been known for a considerable time, that the diamond, the most beautiful and most unchangeable of the productions of nature, is combustible, or that when heated with oxygen gas it suffers combustion. Lavoisier made some experiments to ascertain the nature of the product of this combustion; and he found it to be an acid precisely the same with that which is produced by the burning of charcoal—what is termed the carbonic acid. He did not, however, ascertain the proportion of it with sufficient accuracy to draw any precise conclusion. Some time after, Mr. Tennant repeated the experiment of oxydizing the diamond, by exposing it to heat along with nitrate of potash in a gold tube. He also found that carbonic acid was formed; and from an experiment on a small scale, it appeared that about the same quantity of carbonic acid was afforded by the oxygenation of the diamond as would have been produced by the combustion of the same weight of charcoal. He concluded that the diamond was

carbon, and differed from charcoal principally in its form and state of aggregation; that in short it might be considered as carbon crystallized.

At length Guyton resolved to examine this subject, and his experiments afforded very important results. The diamond on which he experimented was burnt in a vessel of oxygen gas, by directing the solar rays upon it through a very powerful lens. It assumed at first a leaden colour; by the farther continuance of the heat its surface appeared charred. At length it appeared sensibly to diminish, and in little more than an hour and a half was entirely consumed. The product of the combustion was then examined, and was found to be pure carbonic acid, the same as that formed in the burning of charcoal; but what surprised Guyton was, the quantity produced was much greater than what would have been produced by the combustion of the same weight of charcoal in oxygen gas: 28 parts of charcoal form by combustion 100 parts of carbonic acid; that is, combined with 72 of oxygen; but from only 17.8 of diamond, the same quantity of carbonic acid is produced, that quantity having combined with 82.1 of oxygen. In other words, 1 part of charcoal combines with 2 of oxygen, forming $3\frac{1}{2}$ of carbonic acid, while one part of diamond requires 4 of oxygen, and produces 5 of acid. As the term carbon in the new nomenclature is understood to be applied to the simple base of carbonic acid, it is evident that it can no longer be applied to the inflammable matter of charcoal; for in that matter it must be combined with some other principle. Guyton supposes that this principle is oxygen, or, that that inflammable body is an oxide of carbon, standing in the same relation to carbon and carbonic acid that nitrous oxide does to nitrogen and nitric acid. Berthollet, on the contrary, has supposed that charcoal contains hydrogen as a constituent part. Whichever of these opinions is adopted, the name carbon, it is obvious, must now be applied to the simple base, and will therefore be the chemical or systematic term appropriated to the diamond. See DIAMOND.

Besides charcoal and carbonic acid, other substances have been discovered to be binary compounds of carbon. The one known by the name of black-lead, or plumbago, approaches nearer to the diamond, or combines with more oxygen in forming carbonic acid than charcoal does; and between charcoal and carbonic acid is a gaseous compound, into the composition of which oxygen enters, though it is still of the nature of an oxide. Carbon too combines with hydrogen and oxygen, forming various elastic compounds. See GAS.

CARBONATES, in chemistry, salts formed by a combination of the alkalies and the carbonic acid. As the acid powers which carbonic acid actually exerts are weak, the changes which it occasions in the properties of the alkalies are in general inconsiderable. They retain their peculiar taste and acrimony, at least to a certain extent: ammonia has still its penetrating odour, and in part its volatility: they still, even when saturated with it, change the vegetable colours to a green. They combine with oils, forming imperfect soaps; and the presence of the carbonic acid scarcely opposes any obstacle to the combinations of their bases with the other acids.

CARBONIC *acid*, a gaseous product of the full saturation of carbon with oxygen. It was made known to chemists by Dr. Black, under the name of fixed air, and may be regarded as the first of the aerial fluids that obtained accurate examination. It is composed of 75 parts of carbon, and 25 of oxygen. See GAS.

CARBONIC *oxide*, in chemistry, a gas supposed to be compounded of carbon and oxygen, in the proportion of about 38 to 62. This gas possesses the mechanical properties of air. It burns with a deep blue flame, and gives out little light. See GAS.

CARBUNCE, in heraldry, a charge or bearing, consisting of eight radii, four whereof make a common cross, and the other four a saltier.

CARBURET, in chemistry, a compound substance, in which carbon is a constituent part. Carburet of iron, long known under the names of plumbago and black-lead, is compounded of 90 parts of carbon and 10 of iron. It is found native, is of a dark grey or blue colour, and has something of a metallic lustre. It is found in many parts of the world, particularly in Cumberland. From the substance obtained there the best black-lead pencils are manufactured.

CARCASE, in architecture, the shell or ribs of a house, containing the partitions, floors, and rafters, made by carpenters; or it is the timber-work (or as it were the skeleton) of a house, before it is lathed and plastered: it is otherwise called the framing.

CARCASSE, or CARCUSS, in the art of war, an iron-case or hollow capacity, about

the bigness of a bomb, of an oval figure, made of ribs of iron, filled with combustible matters, as meal powder, salt-petre, sulphur, broken glass, shavings of horns, turpentine, tallow, &c. The design of it is to be thrown out of a mortar to set houses on fire, and do other execution. It has two or three apertures through which the fire is to blaze.

CARD, among artificers, an instrument consisting of a block of wood, beset with sharp teeth, serving to arrange the hairs of wool, flax, hemp, and the like: there are different kinds of them, as hand-cards, stock-cards, &c.

CARDS, among gamesters, little pieces of fine thin pasteboard of an oblong figure, of several sizes, but most commonly in England three inches and an half long, and two and an half broad, on which are painted several points and figures. The moulds and blocks for making cards are exactly like those that were used for the first books: they lay a sheet of wet or moist paper on the block, which is first slightly done over with a sort of ink made with lamp-black diluted in water, and mixed with some starch to give it a body. They afterwards rub it off with a round list. The court-cards are coloured by means of several patterns, styled stane-files. These consist of papers cut through with a pen-knife, and in the apertures they apply severally the various colours, as red, black, &c. These patterns are painted with oil-colours, that the brushes may not wear them out; and when the pattern is laid on the paste-board, they slightly pass over it a brush full of colour, which, leaving it within the openings, forms the face or figure of the card.

CARDAMINE, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ or Cruciform flowers. Essential character; silique opening elastically, the valves revolute; stigma entire; calyx rather gaping. There are eighteen species, of which C. bellidifolia has a simple root, white, and very long; stem filiform, striated, flexile, an inch long. Flowers white, sometimes purplish, with claws the length of the calyx; siliques half an inch in length. This plant has no smell. It flowers in July and August.

CARDAMOM, in the materia medica, is distinguished into three kinds, exclusive of the amomum, which is evidently of the cardamom kind. They are called by the names of the great cardamom, or grain of paradise; the long or middle cardamom; and the lesser common cardamom of the shops.

CARDAN (HIERONYMUS), in biography, was born at Pavia, Sept. 24, 1501. At four years old he was carried to Milan, his father being an advocate and physician in that city: at the age of twenty he went to study in the university of the same city, and two years afterward he gave lectures on Euclid. In 1524 he went to Padua; the same year he was admitted to the degree of Master of Arts, and the year following to that of Doctor of Physic. In 1539 he was admitted a member of the College of Physicians at Milan: in 1543 he read public lectures on medicine there, and the same at Pavia the year following; but he discontinued them because he could not get payment of his salary, and returned to Milan.

In 1552 he went into Scotland, having been sent for by the Archbishop of St. Andrews, to cure him of a grievous disorder, after trying the physicians of the King of France and of the Emperor of Germany, without benefit. He began to recover from the day that Cardan prescribed for him. Our author took his leave of him at the end of about six weeks, leaving him prescriptions which in two years wrought a complete cure. Upon this visit Cardan passed through London, and calculated King Edward's nativity, being famous for his knowledge in astrology. Returning to Milan, after four months' absence, he remained there till the beginning of October, 1552, and then went to Pavia, from whence he was invited to Bologna in 1562. He taught in this last city till the year 1570; at which time he was thrown into prison; but some months after he was sent home to his own house. He quitted Bologna in 1571, and went to Rome, where he lived for some time without any public employment. He was however admitted a member of the College of Physicians, and received a pension from the Pope till the time of his death, which happened at Rome on the 21st of September, 1575.

No man of his time seems to have made greater progress in philosophy, medicine, and other branches of natural science, than Cardan; in algebra he was a great adept, and made many improvements in the analytic art. His dexterity in solving cubic equations has given him a lasting name. It is affirmed by Scaliger, that Cardan having, by his pretended skill in astrology, predicted the time of his death, abstained from all

food, in order that he might verify the truth of his prophecy.

CARDINAL, in a general sense, an appellation given to things on account of their pre-eminence: thus we say, cardinal winds, cardinal virtues, &c.

The cardinal virtues are these four, justice, prudence, temperance, and fortitude, upon which all the rest hinge.

Cardinal *points*, in cosmography, are the four intersections of the horizon with the meridian, and the prime vertical circle. Of these, two, *viz.* the intersections of the horizon and meridian, are called north and south, with regard to the poles they are directed to. The other two, *viz.* the intersections of the horizon and first vertical, are called east and west. The cardinal points therefore coincide with the four cardinal regions of the heavens, and are 90° distant from each other. The intermediate points are called collateral points.

Cardinal *signs*, in the zodiac, are Aries, Libra, Cancer, and Capricorn.

Cardinal, more particularly, signifies an ecclesiastical prince in the Romish church, being one who has a voice in the conclave at the election of a Pope. The cardinals were originally nothing more than deacons, to whom was entrusted the care of distributing the alms to the poor of the several quarters of Rome; and as they held assemblies of the poor in certain churches of their several districts, they took the title of these churches. They began to be called cardinals in the year 300, during the pontificate of St. Sylvester, by which appellation was meant the chief priests of a parish, and next in dignity to a bishop. This office grew more considerable afterwards, and by small degrees arrived at its present height, in which it is the reward of such as have served his holiness well, even princes thinking it no diminution of their honour, to become members of the college of cardinals.

The cardinals compose the Pope's council, and till the time of Urban VIII. were styled most illustrious; but by a decree of that Pope in 1630, they had the title of eminence conferred upon them.

At the creation of a new cardinal, the Pope performs the ceremony of shutting and opening his mouth, which is done in a private consistory. The shutting his mouth, implies the depriving him of the liberty of giving his opinion in congregations; and the opening his mouth, which is performed fifteen days after, signifies the taking off this restraint. However, if the Pope happens to die during the time a cardinal's mouth is shut, he can neither give his voice in the election of a new Pope, nor be himself advanced to that dignity.

The privileges of the cardinals are very great: they have an absolute power in the church during the vacancy of the holy see: they have a right to elect the new Pope, and are the only persons on whom the choice can fall: most of the grand offices in the court of Rome are filled by cardinals. The dress of a cardinal is a red sourtanne, a rochet, a short purple mantle, and a red hat. When they are sent to the courts of princes, it is in quality of legates a latere; and when they are appointed governors of towns, their government is called by the name of legation.

CARDING, the combing and preparing of wool, cotton, flax, &c. with the instruments called cards.

CARDIOID, in the higher geometry, an algebraical curve, so called from its resemblance to a heart.

CARDIOSPERMUM, in botany, a genus of the Octandria Trigynia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx four-leaved; petals four; nectary four-leaved, unequal; capsules three, cornate, inflated. There are three species, all of them natives of warm countries. They are annual, and perish soon after they have perfected their seeds. They do not thrive with us, excepting in a stove.

CARDIUM, in natural history, the *cockle*, a genus of worms of the order Testacea; animal a tethys; shell bivalve, nearly equilateral, equivalve, generally convex, longitudinally ribbed, striate or grooved, with a toothed margin; hinge with two teeth near the beak, and a larger remote lateral on each side, each locking into the opposite. There are nearly 60 species.

CARDUUS, in botany, *English thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Juss. Essential character: calyx ovate, imbricate, with spiny scales; receptacle hairy. There are fifty-one species. Little need be said of this genus; nature having made abundant provision for their increase, by annexing to their seeds a light down, which makes them readily float in the air, and scatters them wide over the neighbouring fields. As they

are usually considered as noxious weeds, rather than ornamental plants, few of them are admitted into the flower-garden, and those few are valued more for their variety, than for their beauty.

CAREENING, in the sea-language, the bringing a ship to lie down on one side, in order to trim and caulk the other side. A ship is said to be brought to the careen, when the most of her lading being taken out, she is hauled down on one side by a small vessel as low as necessary; and there kept by the weight of the ballast, ordnance, &c. as well as by ropes, lest her masts should be strained too much; in order that her sides and bottom may be trimmed, seams caulked, or any thing that is faulty under water mended. Hence when a ship lies on one side when she sails, she is said to sail on the careen.

CARET, among grammarians, a character marked thus ʌ, signifying that something is added on the margin, or interlined, which ought to have come in where the caret stands.

CAREX, in botany, *English sedge*, a genus of the Monoecia Triandria class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: ament imbricate; calyx one-leafed; corolla none; female, nectary inflated; three-toothed; stigmas three; seeds three-sided, within the nectary. There are ninety-seven species. These plants are very nearly allied to the grasses, agreeing with them in their general appearance and leaves. They are however of a much harsher texture; the stem is not hollow, but filled with a spongy substance. The difference in the fructification is very considerable, as will appear from a comparison of the generic characters. They are perennial, and flower in May and June. The carices or sedges are classed rather among the noxious plants than with such as are useful, for they yield a very coarse grass and fodder, to the exclusion of real grass and other profitable plants, which they subdue by their strong creeping roots.

CARGO denotes all the merchandise and effects which are laden on board a ship, exclusive of the crew, rigging, ammunition, provisions, guns, &c. though all these load it sometimes more than the merchandise.

We say that a ship has its cargo, when it is as full of merchandise as it can hold; that it has half its cargo, when it is but half full; that it brings home a rich cargo, when it is laden with precious merchandise, and in great quantity; that a merchant has made the whole cargo of the ship, or only one half, or one quarter of the cargo, when he has laden the whole ship at his own expense, or only one half or one fourth of it.

Disposing of any part of the cargo, before the vessel reaches her intended port, is called breaking bulk.

Cargo, *super*, a person employed by merchants to go a voyage, and oversee the cargo, and dispose of it to the best advantage.

CARICA, in botany, a genus of the Dioceia Decandria, or rather Polygamia class and order. Natural order of Tricoccæ. Cucurbitaceæ, Jussieu. Essential character: male calyx very small, five-toothed; corolla five-parted, funnel form; filaments in the tube of the corolla, alternately shorter; herm. calyx five-toothed; corolla five-parted; stigmas five; berry one-celled, many-seeded. There are two species, *viz.* C. papaya, common papaw-tree, and C. posoposo, dwarf papaw-tree. These plants, being natives of hot countries, will not thrive in England without the assistance of the warm stove. Where there are conveniences of a proper height, they deserve a place as well as almost any of the plants which are cultivated for ornament. They grow to the height of twenty feet, with upright stems, garnished on every side near the top with large shining leaves. The flowers of the male sort come out in clusters on all sides, and the fruit of the female growing round the stalks between the leaves, forming altogether a beautiful appearance.

CARICATURA, in painting, denotes the concealment of real beauties, and the exaggeration of blemishes, but still so as to preserve a resemblance of the object.

CARIES, in surgery, the corruption of a bone when it is deprived of its periosteum, and becomes fatty, yellow, brown, and at last black. See Surgery.

CARINA, in botany, a keel, the name which Linnæus gives to the lower concave petal of a pea-bloom, or butterfly-shaped flower, from its supposed resemblance to the keel of a ship.

CARISSA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: corolla contorted; berries two, many-seeded. There are two species, natives of the East Indies and Africa.

CARLINA, in botany, English *carline thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compound Flowers: division of Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx radiated, with long, coloured, marginal scales. There are nine species, most of them natives of the South of France, Italy, and Spain.

CARLINES, or CARLINGS, in a ship, two pieces of timber, lying fore and aft, along from beam to beam, whereon the ledges rest on which the planks of the ship are fastened. All the carlings have their ends let into the beams culvertail-wise: they are directly over the keel, and serve as a foundation for the whole body of the ship.

CARMINATIVES, in pharmacy, medicines used in cholics, or other flatulent disorders, to dispel the wind. See PHARMACY.

CARMINE, a powder of a very beautiful red colour, bordering upon a purple, and used by painters in miniature, though but rarely, because of its great price.

CARNATION, in botany. See DIANTHUS.

CARNATION *colour*, among painters, is understood of all the parts of a picture, in general, which represent flesh, or which are naked and without drapery.

CARNELIAN. See CHALCEDONY.

CARNIVAL, or CARNAVAL, a time of rejoicing, a season of mirth, observed with great solemnity by the Italians, particularly at Venice, lasting from Twelfth-day till Lent.

CARNIVOROUS, in zoology, an epithet generally applied to animals of every description that subsist for the most part, or entirely, on animal food. In a more limited sense we understand by carnivorous animals, those only of a savage and voracious nature, assimilating in our ideas some instinctive ferocity of character in the manners of those creatures when seeking and attacking their prey, as well as actually feeding on flesh. We naturally consider, for this reason, among the principal carnivorous animals the lion, the tiger, and the wolf; or among birds, the eagle and the kite, with a host of other rapacious creatures, upon which nature has bestowed preeminent advantages of courage, strength, and arms, to aid them in seizing upon, and tearing into pieces, those animals on which they feed: they have either formidable canine teeth or fangs; claws or talons; the quadrupeds possessing both, and the birds the latter. Fishes, with very few exceptions, are carnivorous, but their only offensive weapons are the teeth, or in some species the spines and prickles disposed on various parts of the body. Quadrupeds that subsist both on flesh and vegetables are more or less deficient with respect to those characters by which carnivorous quadrupeds are known; and those still more so that subsist entirely on roots, barks, fruits, grass, or other vegetables: the brutæ have no cutting teeth either in the upper or lower jaw; the pecoræ have them only in the lower jaw; and the front teeth of the belluæ are obtuse. The food of those animals is vegetables. See MAMMALIA.

Carnivorous animals are characterized both by their internal organization, and their capacity and inclination for the destruction of their prey; their teeth are sharp and pointed, even though situated in the back part of the mouth; and these teeth, denominated canine, are so long in most of the beasts of prey that they pass a considerable way beyond each other when the jaws are closed. The distribution of the enamel which is confined to the superficies of the teeth renders them extremely hard, and this circumstance, joined to an extraordinary bulk of those muscles employed in raising the lower jaw, gives to carnivorous quadrupeds the power of breaking the strongest bones.

The rapacious birds are distinguished by a sharp hard bill, furnished on each side with a pointed process, by which they are enabled to tear asunder the parts of the animals they feed upon. As the digestion of animal substances is accomplished in a short time, the stomach of the carnivorous tribes has a simple figure without any processes or separations of its cavity to retain its contents, or to delay their passage into the intestines; and as animal food furnishes but little excrement, the intestinal canal is short, and either totally unprovided with those dilatations which are so remarkable in vegetable eaters, or possesses them only in a slight degree.

Carnivorous animals are further distinguished by the extraordinary strength of their members, which are commonly furnished with sharp claws; these are so contrived, both in the beasts of prey and the accipitrine birds, that they turn inwards by the flexion of the limbs, or the action of seizing any thing, and are retracted by the extension of the toes; thus giving facility and certainty to the capture and retention of fugitive animals. The senses of vision and

smell are particularly acute in the carnivorous tribes, as it is by means of them that they discover or seek out their prey.

Carnivorous animals are usually cruel and treacherous in their dispositions; they are even unsocial with respect to their own species; and hence it is that their numbers are so few in comparison to that of the graminivorous kind: if it were not for this wise ordinance of nature the defenceless orders of animals would soon be devoured, and the carnivorous would become the prey of each other.

CARNOSITY, a term sometimes used for an excrescence, or tubercle, in the urethra, the neck of the bladder, &c.

CAROLINEA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: monogynous; calyx simple, tubular, truncate; petals ensiform; pome five-grooved, two-celled. There are two species, of which C. princeps is a large thornless tree. Leaves alternate; stipules two, short, caducous. Flowers solitary, very large and beautiful; petals yellow. The fruit has the appearance of that of the chocolate or of cucumber, with seeds like almonds; native of Guiana.

CAROLUS, an ancient English broad piece of gold, struck under Charles I. Its value has of late been at twenty-three shillings sterling, though at the time it was coined, it is said to have been rated at only twenty shillings.

CAROLUS, a small copper coin, with a little silver mixed with it, struck under Charles VIII. of France.

CAROTIDS, in anatomy, two arteries of the neck, which convey the blood from the aorta to the brain, one called the right carotid, and the other the left. See ANATOMY.

CAROXYLON, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla five-petalled; nectary five-leaved, converging, inserted into the corolla; seed clothed. There is but one species, *viz.* C. salsola; has a perennial root; stem arborescent, erect, very branching, naked. Leaves on the branchlets, frequent, imbricate, sessile, subglobular, ovate, concave within and smooth; axils loaded with other leaves. In Africa they use the ashes with mutton suet to make soap.

CARPENTRY, the art of cutting, framing, and joining large pieces of wood, for the uses of building. It is one of the arts subservient to architecture, and is divided into house-carpentry and ship-carpentry; the first is employed in raising, roofing, flooring of houses, &c. and the second in the building of ships, barges, &c. The rules in carpentry are much the same with those of joinery; the only difference is, that carpentry is used in the larger coarser work, and joinery in the smaller and curious.

CARPESIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compound flowers; division of Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate; the outer scales reflex; down none; receptacle naked. There are two species, *viz.* C. cernuum, drooping carpesium, is a native of the south of France, Italy, Carniola, Austria, Switzerland, and Japan; and C. abrotanoides is a native of China and Japan.

CARPET: this beautiful covering for floors is of several descriptions, being made of various materials, and various forms. The Turkey, Persia, and Brussels carpets, are chiefly made of silk; the two former, owing to the vivid colours with which the materials are dyed, and the fineness of the texture, are peculiarly rich and beautiful. We have various extensive manufactories, of which those at Wilton and Kidderminster may be accounted the principal. Carpets are there made in large pieces, suited to the full extent of apartments; while the Scotch carpetting, being made in breadths of not more than four feet, affords the convenience of making up to any size; but it is not so lasting. The great carpets are made on frames and rollers not unlike those for tapestry, and under similar guidance where the pattern is intricate. Carpet-making supports many thousands of the industrious poor of this country; and being almost wholly found on the produce of our own island is of great importance as a national benefit.

CARPHALEA, in botany, a genus of the Tetrandia Monogynia class and order: corolla one-petalled, funnel-form, hairy within; calyx four-cleft, with spatulate scarious segments; capsule two-celled, two-valved, many seeded. One species, C. corymbosa, found in Madagascar.

CARPINUS, in botany, *English hornbeam*, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character: calyx one-leafed, with a ciliate scale; corolla none; male stamens twenty; female germs two,

with two styles on each; nut ovate. There are four species, of which C. betulus, hornbeam, is very common in many parts of England, but is rarely suffered to grow as a timber tree, being generally reduced to pollards by the country people; but where the young trees have been properly treated they have grown to a large size, nearly seventy feet in height, with large fine stems, perfectly straight and sound.

CARPODETUS, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-toothed, fastened to the germ; corolla five-petalled; stigma flat-headed; berry globular, five-celled. There is but one species, *viz.* C. serratus, a native of New Zealand.

CARR, among the ancients, a kind of throne, mounted on wheels, and used in triumphs and other solemn occasions. The carr on medals, drawn by horses, lions, or elephants, signifies a triumph, or an apotheosis; sometimes a procession of the images of the gods at a solemn supplication; and sometimes of those of some illustrious families at a funeral. The carr, covered and drawn by mules, only signifies a consecration, and the honour done any one of having his image carried at the games of the circus.

CARRIAGE, *letter or bill of*, a writing given to a carrier or the master of any carriage, containing the number and quality of of the pieces, bales, &c. of merchandises, which he is intrusted with, that he may demand the payment of the carriage, and that the person to whom they are addressed may see whether they are delivered in the same number, and in as good condition, as they were given to the carrier.

CARRIAGE *of a cannon*, the frame or timber-work on which it is mounted, serving to point it for shooting, or to carry it from one place to another. It is made of two planks of wood, commonly one half the length of the gun, called the cheeks, and joined by three wooden transums, strengthened with three bolts of iron. It is mounted on two wheels; but on a march has two fore-wheels, with limbers added. The principal parts of a carriage are the cheeks, transums, bolts, plates, train, bands, bridge, bed, hooks, trunion-holes, and capsquare.

CARRIAGES. This subject, in detail, would form many an ample volume. The great variety of opinions, the imperious demands of locality, and the appropriation to particular purposes, must inevitably create a curious diversity in the practices of a nation. Confining ourselves to general principles, we shall discuss only those points which serve as a general guide, and may prove useful in giving the reader some idea as to the several properties of the vehicles now in use.

1. We consider ease of draught as indispensable. For this purpose the fore-wheels of a carriage should always be sufficiently large to bring the centre of the axle to an angle, of about fifteen degrees, with that part of the haime, or collar-frame, on which the trace fixes; that being ascertained to be the best relative position between the animal and what he has to draw at.

2. We look to proximity of rotation, that is, the place where the wheel touches the ground, and its relation to a perpendicular draft from the croup of the horse, as being an essential matter: for the draft will assuredly be more oppressive in proportion as the point of rotation is removed. Hence long shafts, great space between the fore and hind wheels, and all the representatives of those primary errors, should be, *in toto*, abolished.

3. We judge the size of wheels, that is, the length of lever by which they are moved around their axis, to be of the greatest moment.

4. Where a road is firm, we hold it expedient to reduce the bearing point, namely the edge of the wheel, into as small a diameter as may be found capable of sustaining the incumbent pressure.

5. Where roads are soft and quaggy, we deem the broad tire to be preferable; both because it bears up the load, and allows of less sinking, whereby considerable opposition would be created; and, that such a construction is more favourable to the track in which the carriage may have often to travel.

6. The axis of every wheel ought to move with as little friction as possible: this may be effected by making the spindle as small and as short as circumstances may allow; taking care to lubricate the connecting parts well, so as not to allow of the smallest tendency to adhesion. Wheels intended for travelling over unequal surfaces should be dished, so that the spokes may successively be upright whenever they come under the axle. The bend of each end of the axle downwards is a convenience, and contributes to the foregoing effect, while it causes the upper parts of the wheels to diverge, and gives more scope for the body of the machine: in some instances, where light but

bulky burthens are in question, this is a desideratum; though it contracts the space between the points of rotation, and renders the machine more liable to overturn. The load should generally be carried more in the centre of four-wheeled carriages than is usually done. Carmen have a great partiality for burthening the fore-wheels: this is a most absurd practice, because they, being less in diameter, are more subject to be impeded by low obstacles than the hind-wheels, which, being larger, travel over ruts and clods with much more facility. In regard to the height of loads, it is proper to state, that whenever a line drawn perpendicular to the horizon, and touching the corner of a square load, touches the ground on the outside of the tire of the opposite wheel, the carriage must overset: the line of gravity then becoming exterior to the support; and *vice versa*. From this we see, that loads carried low are in general very safe; while such as are injudiciously elevated, which too many of our stage-coaches are, teem with danger. In two-wheel carriages, the load in going down hill bears extremely heavy on the shaft-horse: this should be obviated by cocking the cart backwards, according to the practice in the West of England.

CARRIER, *laws relating to*. Every person carrying goods for hire is deemed a carrier, and as such is liable in law for any loss or damage that may happen to them whilst in his custody. Waggoners, captains of ships, lightermen, &c. are therefore carriers; but a stage-coachman is not within the custom as a carrier: neither are hackney-coachmen carriers within the custom of the realm, so as to be chargeable for the loss of goods, unless they are expressly paid for that purpose, for their undertaking is only to carry the person. If a person take hire for carrying goods, although he be not a common carrier, he may nevertheless be charged upon a special assumpsit; for where hire is taken, a promise is implied; and where goods are delivered to a carrier, and he is robbed of them, he shall be charged and answer for them on account of the hire, and the carrier can be no loser, as he may recover against the hundred.

Goods sent by a carrier cannot be distrained for rent; and any person carrying goods for all persons indifferently is to be deemed a common carrier, as far as relates to this privilege. A delivery to a servant is a delivery to the master, and if goods are delivered to a carrier's porter and lost, an action will lie against the carrier.

Where a carrier gives notice by printed proposals, that he will not be responsible for certain valuable goods if lost, if more than the value of a sum specified, unless entered and paid for as such; and valuable goods of that description are delivered to him, by a person who knows the conditions, but concealing the value, pays no more than the ordinary price of carriage and booking, the carrier is, under such circumstances, neither responsible to the sum specified, nor liable to repay the sum paid for carriage and booking.

A carrier who undertakes for hire to carry goods, is bound to deliver them at all events, unless damaged and destroyed by the act of God, or the king's enemies; and if any accident, however inevitable, happen through the intervention of human means, a carrier becomes responsible.

CARRONADE, a cannon of peculiar construction, being much shorter and lighter than the common cannon, and having a chamber for the powder like a mortar; they are generally of a large calibre, and carried on the upper works, as the poop and forecastle. They are named from Carron in Scotland, the town in which they were first made.

CARTES (RENES DES), in biography. Few persons have a higher claim to distinction than this philosopher; we shall therefore, in the present article, interweave an account of his system with that of his life.

Des Cartes was a native of Touraine, in France, and born in 1596. While a child he discovered an eager curiosity to inquire into the nature and causes of things, which procured him the apellation of the young philosopher. At eight years of age he was committed to the care of a Jesuit, under whom he made very uncommon proficiency. He soon began to discover defects in existing systems, and hoped to be the means of giving to science a new and more pleasing aspect. After spending five years in the study of the languages and polite literature in general, he entered upon a course of mathematics, logic, and morals, according to the methods by which they were then taught. With these he was so much disgusted, that he determined to frame for himself a brief system of rules or canons of reasoning, in which he followed the strict method of the geometricians. He pursued the same plan with respect to morals. Af-

ter all, however, he was so little satisfied with his own attainments, that he left college, lamenting that the fruits of eight years' study were only the full conviction that as yet he knew nothing with perfect clearness and certainty. He even threw aside his books with a resolution to pursue no other knowledge than that which he could find within himself and in the great volume of nature. At the age of seventeen he was sent to Paris, where the love of pleasure, for a moment, seemed to overcome all desire of philosophical distinction, but an introduction to some learned men recalled his attention to mathematical studies; these he again prosecuted in solitude and silence for the space of two years, after which he entered as a volunteer in the Dutch army, in order that he might study the living world as well as read books. In this situation he wrote a dissertation to prove that brutes are automata. From the Dutch army Des Cartes passed over to the Bavarian service, but wherever he went he conversed with learned men, and rather appeared in the character of a philosopher than that of a soldier. In 1622 he quitted the army, returned to his own country, with no other profit, he said, than that he had freed himself from many prejudies, and rendered his mind more fit for the reception of truth. He fixed his residence at Paris, and began to study the mathematics, in hopes of discovering general principles of relations, measures, and proportions, applicable to all subjects, by means of which truth might with certainty be investigated, and the limits of knowledge enlarged. From mathematics he turned his attention to ethical inquiries, and attempted to raise a superstructure of morals upon the foundation of natural science, conceiving that there could be no better means of discovering the true principles and rules of action, than by contemplating our own nature, and the nature of the world around us. As the result of these inquiries, he wrote a treatise on the passions. After some time spent in Italy, whither he went in pursuit of knowledge, he returned again to Paris, and from thence he went to Holland, with a view of raising a new system of philosophy. Here he chose retirement, as the best means of forwarding the plans which he hoped to execute. He employed himself in investigating a proof from reason, independently of revelation, of the fundamental principles of religion, and published "Philosophical Meditations on the First Philosophy." At the same time he pursued his physical inquiries, and published a treatise "On Meteors." He paid considerable attention to medicine, anatomy, and chemistry; and wrote also an astronomical treatise on the system of the world, which he suppressed upon hearing of the vile and infamous treatment that Galileo had met with for his discussions on the same subject. See GALILEO.

The Cartesian philosophy was first taught in the schools of Deventer, 1633: it attracted many zealous admirers, and excited against him a host of opponents. The system of Des Cartes obtained so much credit in Great Britain, that the inventor was invited to settle in England, as well by the King as by some of the principal nobility. This invitation he would probably have accepted had not the civil wars prevented Charles I. from being able to render the philosopher all the patronage which he had formerly tendered him. At this period he was forced into many disputes, in the course of which, as well as by his collateral conduct, he displayed an eager desire to be considered the father of a sect, and discovers more jealousy and ambition than became a philosopher.

During Des Cartes's residence in Holland, he went occasionally to his native country, where, in 1643, he published an abstract of his philosophy, under the title of "Philosophical Specimens." He was promised, on one of these visits, an annual pension of 3000 livres, which he never received. He was now invited by Christina, Queen of Sweden, to visit Stockholm. That learned princess had read with delight his treatise "On the Passions," and was earnestly desirous to be instructed by him in the principles of philosophy. Des Cartes arrived at Stockholm in 1649, where he received a most friendly and respectful reception from the enlightened queen, who urged him to settle in her kingdom, and assist her in establishing an academy of sciences. He had, however, been scarcely four months in that severe climate, when, in his visits to the sovereign, whom he instructed in the principles of philosophy, he caught a cold, which brought on an inflammation in his lungs that put a period to his life, in 1650. His remains were interred in the cemetery for foreigners, and a long eulogium inscribed on his tomb: but in 1666 his bones were transported to France, and placed with all the circumstances of pomp

in the church of St. Genevieve. Such was the life of this great man: his writings and system require a more detailed account.

On the subject of logic, he says, nothing is ever to be admitted as true, which is not certainly and evidently known to be so, and which cannot be possibly doubted. In proving any truth, the ideas are always to be brought forward in a certain order, beginning from things the most simple, and advancing by regular steps to those which are more complex and difficult. With regard to metaphysics, Des Cartes says, that since man is under the influence of prejudice, he ought, once in his life, to doubt of every thing; even whether sensible objects have a real existence; and also of the truth of mathematical axioms. The first principle of the Cartesian philosophy is this, "I THINK, THEREFORE I AM:" this is the foundation of Des Cartes's metaphysics: that on which his physics is built, is, "THAT NOTHING EXISTS BUT SUBSTANCES." Substance he makes of two kinds; the one that thinks, the other is extended: so that actual thought and actual extension make the essence of substance. The essence of matter being thus fixed in extension, Des Cartes concludes that there is no vacuum, nor any possibility of it in nature, but that the universe is absolutely full: by this principle, mere space is quite excluded; for extension being implied in the idea of space, matter is so too.

Des Cartes defines motion to be the translation of a body from the neighbourhood of others that are in contact with it, and considered as at rest, to the neighbourhood of other bodies: by which he destroys the distinction between motion that is absolute or real, and that which is relative or apparent. He maintains that the same quantity of motion is always preserved in the universe, because God must be supposed to act in the most constant and immutable manner: and hence also he deduces his three laws of motion.

Upon these principles Des Cartes explains mechanically how the world was formed, and how the present phenomena of nature came to arise. He supposes that God created matter of an indefinite extension, which he separated into small square portions or masses, full of angles: that he impressed two motions on this matter; the one, by which each part revolved about its own centre; and another, by which an assemblage or system of them turned round a common centre. From whence arose as many different vortices, or eddies, as there were different masses of matter, thus moving about common centres.

The consequence of these motions in each vortex, according to Des Cartes, is as follows: the parts of matter could not thus move and revolve amongst one another, without having their angles gradually broken; and this continual friction of parts and angles must produce three elements: the first of these, an infinitely fine dust, formed of the angles broken off; the second, the spheres remaining, after all the angular parts are thus removed; and those particles not yet rendered smooth and spherical, but still retaining some of their angles, and hamous parts, from the third element.

Now the first or subtilest element, according to the laws of motion, must occupy the centre of each system, or vortex, by reason of the smallness of its parts: and this is the matter which constitutes the sun, and the fixed stars above, and the fire below. The second element, made up of spheres, forms the atmosphere, and all the matter between the earth and the fixed stars; in such sort, that the largest spheres are always next the circumference of the vortex, and the smallest next its centre. The third element, formed of the irregular particles, is the matter that composes the earth, and all terrestrial bodies, together with comets, spots in the sun, &c.

He accounts for the gravity of terrestrial bodies from the centrifugal force of the ether revolving round the earth: and upon the same general principles he pretends to explain the phenomena of the magnet, and to account for all the other operations in nature.

Of this great man many eulogia have been published, by persons very capable of appreciating his worth and his talents. We shall mention the opinion entertained of him by two or three of our own countrymen.

Dr. Barrow, in his "Opuscula," observes, that Des Cartes was doubtless a very ingenious man, and a real philosopher, and one who seems to have brought those assistances to that part of philosophy relating to matter and motion, which perhaps no one had done before; namely, a great skill in mathematics; a mind habituated, both by nature and custom, to profound meditation; a judgment exempt from all prejudices and popular errors, and furnished with a good number of certain and select experiments; a great deal of leisure;

an entire disengagement, by his own choice, from the reading of useless books, and the avocations of life; with an incomparable acuteness of wit, and an excellent talent of thinking clearly and distinctly, and of expressing his thoughts with the utmost perspicuity.

Dr. Halley, in a paper concerning optics, affirms that Des Cartes was the first who, in modern times, discovered the laws of refraction, and brought dioptrics to a science. And Dr. Keil says, that Des Cartes was so far from applying geometry and observations to natural philosophy, that his whole system is but one continued blunder, on account of his negligence in that point; which he could easily prove, by showing that his theory of the vortices, upon which his system is founded, is absolutely false, for that Newton has shown that the periodical times of all bodies that swim in vortices, must be directly as the squares of their distances from the centre of them; but it is evident from observations, that the planets, in moving round the sun, observe a law quite different from this; for the squares of their periodical times are always as the cubes of their distances: and therefore, since they do not observe that law, which of necessity they must, if they swim in a vortex, it is a demonstration that there are no vortices in which the planets are carried round the sun.

CARTHAMUS, in botany, English *bastard saffron*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ, or compound flowers, and division of Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx ovate, imbricate with scales, which at the end are subovate-foliaceous. There are ten species, of which C. tinctorius, officinal bastard saffron, is an annual plant; it is two feet and a half high, dividing upwards into many branches, with ovate-pointed sessile leaves. The flowers grow single at the extremity of each branch, the heads are large, inclosed in a scaly calyx. It flowers in July and August. It grows naturally in Egypt, and in some of the warm parts of Asia.

CARTILAGE, in anatomy, a body approaching much to the nature of bones. See ANATOMY.

Cartilage has so much induration, as to require the exertion of some force to bend it; and in a morbid state it frequently becomes ossified. Bone, on the other hand, is, in the first stages of their growth, cartilaginous: it sometimes becomes so from disease. A cartilaginous matter exists in the hardest bones, and forms their basis; from which the other ingredients, the gelatine and earthy matter, may be removed. Cartilages are solid, but easily cut: they are elastic, dense, white, and semi-transparent. They cover the articulated extremities of bones, and sometimes form distinct parts. The matter of cartilage has been examined by Mr. Hatchett, who considers it as indurated albumen.

CARTILAGINOUS *fishes*, those with cartilaginous instead of bony skeletons: they constitute an order of fishes, answering to the Chondropterygious and Branchiostegious of Linnæus. See CHONDROPTERYGIOUS.

CARTON, or CARTOON, in painting, a design drawn on strong paper to be afterwards traced through, and transferred on the fresh plaster of a wall to be painted in fresco.

In Italian, whence the term seems to be derived, cartone, or cartoni, signifying large paper, denotes several sheets of paper pasted on canvas, on which large designs are made, whether coloured or with chalks only. Of these cartoons there are many by Dominichino, Leonardo da Vinci, Andrea Mantegna, Michael Angelo, &c.; but the most celebrated performances of this kind are the cartoons of Raphael, or Raffaello Sanzio Da Urbino, which are seven in number, and form only a small part of the sacred historical designs executed by this famous artist, while engaged in the chambers of the Vatican, under the auspices of Pope Julius II. and Leo X. As soon as they were finished, they were sent to Flanders, to be copied in tapestry, for adorning the pontifical apartments; but the tapestries were not conveyed to Rome till after the decease of Raphael, and probably not before the dreadful sack of that city in 1527, under the pontificate of Clement VII.; when Raphael's scholars having fled from thence, none were left to inquire after the original cartoons, which lay neglected in the store-rooms of the manufactory. The revolution that happened soon after in the Low Countries prevented their being noticed during a period in which works of art were wholly neglected. These seven, however, escaped the wreck of the others, which were torn in pieces, and of which some fragments remain in different collections. These were purchased by Rubens for Charles I., but they had been much injured. In this state they also fortunately

escaped being sold in the royal collection, by the disproportionate appraisement of these seven at 300*l.*; and the nine pieces, which were the triumph of Julius Cæsar, by Andrea Mantegna, appraised at 1,000*l.* The cartoons seem to have been little noticed till King William III. built a gallery for the purpose of receiving them at Hampton Court. After having suffered much from the damps of the situation in which they were placed, they were removed by order of his present Majesty, King George III. to the Queen's Palace at Buckingham House, and from thence to the Castle at Windsor. These cartoons are justly represented as "the glory of England, and the envy of all other polite nations;" and his Majesty is entitled to a tribute of respect and applause for his care in preserving these precious treasures. They have been long deservedly held in high estimation throughout Europe by all authors of refined taste, and by all the admirers of the art of design, for their various and matchless merit, particularly with regard to the invention, and to the noble expression of such a variety of characters, countenances, and attitudes, as they are differently affected and suitably engaged, in every composition.

CARTOUCHE, in architecture and sculpture, an ornament representing a scroll of paper. It is usually a flat member, with wavings, to represent some inscription, vice, cypher, or ornament of armoury. They are, in architecture, much the same as modillions; only these are set under the cornice in wainscotting, and those under the cornice at the eaves of a house.

Cartouche, in the military art, a case of wood, about three inches thick at the bottom, girt with marlin, holding about four hundred musket balls, besides six or eight balls of iron, of a pound weight, to be fired out of a howitzer, for the defence of a pass, &c.

A cartouche is sometimes made of a globular form, and filled with a ball of a pound weight; and sometimes it is made for the guns, being of ball of half or quarter pound weight, according to the nature of the gun, tied in form of a bunch of grapes, on a tompion of wood, and coated over.

CARTRIDGE, in the military art, a case of pasteboard or parchment, holding the exact charge of a fire-arm. Those for musquets, carabines, and pistols, hold both the powder and ball for the charge; and those of cannon and mortars are usually in cases of pasteboard or tin, sometimes of wood, half a foot long, adapted to the calibre of the piece.

Cartridge *box*, a case of wood or turned iron, covered with leather, holding a dozen musquet cartridges. It is worn upon a belt, and hangs a little lower than the right pocket-hole.

CARTS, *laws relating to*. Carts for the carriage of any thing, to and from any place where the streets are paved within the bills of mortality, shall contain six inches in the felly: the name of the owner must be on some conspicuous part, and his name entered with the commissioners of the hackney-coaches, under the penalty of 40*s.*, and any person may seize and detain such cart till the penalty is paid. On changing property, the names are to be altered, and new entries made. Every driver of a cart riding upon it, without having a person on foot to guide it, shall forfeit 20*s.* if he is the owner, and 10*s.*, if he is the servant only.

CARUM, in botany, English *caraway*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit ovate, oblong, striated; involucre one-leafed; petals keeled, inflex-emarginate. There is but one species, *viz.* C. carui, common caraway, a biennial plant; it has a taper root like a parsnip, but much smaller, running deep into the ground, sending out many small fibres, and having a strong aromatic taste. It is particularly cultivated in Essex.

CARUNCULA, in anatomy, a term denoting a little piece of flesh, and applied to several parts of the body: thus, Caruncula lacrymalis, a little eminence situated in the larger angle, or canthus of the eye, where there are also sometimes hairs and certain little glands.

CARUS, in medicine, a sudden deprivation of sense and motion, affecting the whole body.

CARYATIDES, or Cariates, in architecture, a kind of order of columns or pilasters, under the figure of women, dressed in long robes, after the manner of the Carian people, and serving instead of columns, to support the entablement. The caryatides should always have their legs pretty close to each other, and even across, or one athwart the other; their arms laid flat to their bodies, or to the head; and as little spread as possible: when they are insulated, they should never have any great weight to support; and they ought always to appear in characters proper to the place they are used in.

CARYOCAR, in botany, a genus of the Polyandria Tetragynia class and order. Essential character: calyx five-parted; petals five; style usually four; drupe with four nuts, reticulated with furrows. There is but one species; *viz.* C. nuciferum, a tall tree, with ternate leaves. Native of Berbice and Essequebo.

CARYOPHYLLÆUS, in natural history, a genus of the Vermes Intestina. Body round; mouth dilated and fringed. One species; *viz.* C. piscium, which inhabits the intestines of various fresh-water fish, particularly the carp, tench, and bream. The body is of a clay colour, about an inch long, rounded at the hind part, and broader before.

CARYOPHYLLUS, in botany, English *clove-tree*, a genus of the Polyandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: corolla four-petalled; calyx four-leaved, duplicate; berry one-seeded, inferior. One species; *viz.* C. aromaticus, clove-tree, rises to the height of a common apple-tree, but the trunk generally divides at about four or five feet from the ground into three or four large limbs, which grow erect, and are covered with a thin smooth bark, which adheres closely to the wood: the leaves are like those of the bay-tree, and are placed opposite on the branches. The flowers are produced in loose bunches at the end of the branches; they are small, white, and have a great number of stamens, which are much longer than the petals. The flowers are succeeded by oval berries, which are crowned by the calyx, divided into four parts, spreading flat on the top of the fruit: it is the young fruit, beaten from the trees before they are half grown, which are the cloves used all over Europe. It is found in all the Moluccas, in many of the South Sea islands, and in New Guinea.

CARYOTA, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Palms. Essential character: male, calyx common; corolla tripartite; stamens very many: female, calyx as in the male; corolla tripartite; pistil one; berry dispermous. There are two species. C. urens is a lofty palm-tree; the trunk is very large, covered with a sort of cinerous crust, which is quite smooth. The flowers are in long pendulous spikes, on which they grow in pairs. The corolla, which is sometimes bipartite, but commonly tripartite, is at first green, then red or purple, and finally yellow. C. mitis is about fifteen feet in height, a most beautiful plant, growing in the woods of Cochinchina.

CASCADE, a steep fall of water from a higher into a lower place. They are either natural, as that at Tivoli, &c. or artificial, as those of Versailles, &c.; and either falling with gentle descent, as those of Sceaux; or in form of a buffet, as at Trianon; or down steps, in form of a perron, as at St. Cloud; or from bason to bason, &c.

CASE, among grammarians, implies the different inflections or terminations of nouns, serving to express the different relations they bear to each other, and to the things they represent. There is great diversity among grammarians, with regard to the nature and number of cases: they generally find six, even in most of the modern languages, which they call the nominative, genitive, dative, accusative, vocative, and ablative; but this seems in compliance with their own ideas of the Greek and Latin, which they transfer to their own languages. The termination is not the sole criterion of a case, for though some authors reckon five cases of nouns in the Greek, and six in the Latin; yet several of these cases are frequently alike: as the genitive and dative singular of the first and fifth declensions of the Latin; the dative and ablative plural of all the declensions, &c.; the genitive and dative dual of the Greek, &c. The English and many other modern languages express the various relations not by changes in the terminations, as the ancients, but by the apposition of articles. Grammarians, however, admit of three cases in the English nouns; *viz.* the nominative, possessive, and objective. The nominative expresses simply the name of a thing, or the subject of the verb; the possessive expresses the relation of property or possession; and the objective expresses the object of an action, or of a relation, and follows a verb active or a preposition.

Case, among printers, denotes a sloping frame, divided into several compartments, containing a number of types or letters of the same kind. From these compartments the compositor takes out each letter as he wants it, to compose a page or form. Thus they say a case of pica, of Greek, &c. Earl Stanhope, who has made great improvements in the printing-press, has contrived a case, which is said to be much more convenient to the workmen than those in common use.

Case-*hardening*, a method of preparing iron, so as to render its outer surface hard,

and capable of resisting any edged tool. The process of case-hardening, which is in truth a superficial conversion of iron into steel, depends on the cementation of it with vegetable or animal coals. We have seen small articles of iron converted into steel, by heating it in a crucible with pieces of leather, horn, &c. The whole must be raised to a great heat by means of a forge, furnace, &c. See IRON.

CASE-*shot*, in the military art, musket-ball, stones, old iron, &c. put into cases, and shot out of great guns.

CASERNS, in fortification, lodgings built in garrison towns, generally near the rampart, or in the waste places of the town, for lodging the soldiers of the garrison. There are usually two beds in each casern for six soldiers to lie, who mount the guard alternately; the third part being always on duty.

CASH, in the commercial style, signifies the stock of money which a merchant, trader, or banker has at his disposal in order to trade.

CASHEW *nut*, the fruit of the acajou tree, reckoned by Linnæus a species of anacardium. See ANACARDIUM.

CASHIER, a person who is entrusted with the cash of some public company.

CASI, in the Persian policy, one of the two judges under the nadab, who decide all religious matters, grant all divorces, and are present at all public acts, having deputies in all the cities of the kingdom. See the article NADAB.

CASING *of timber work*, among builders, is the plastering a house all over on the outside with mortar, and then striking it while wet by a ruler with the corner of a trowel, to make it resemble the joints of free-stone. Some direct it to be done upon heart laths, because the mortar would, in a little time, decay the sap laths; and to lay on the mortar in two thicknesses, *viz.* a second before the first is dry.

CASSAVA, in chemistry, a species of starch prepared from the roots of the jatropha manihat, an American plant. They are peeled and pressed, and the juice that is forced out is a deadly poison, and employed by the Indians to poison their arrows. It deposits, however, a white starch, which when properly washed is perfectly innocent, and when dried is used in the preparation of bread.

CASSIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx pentaphyllous; petals five; the three superior anthers sterile; the three inferior beaked; legume. There are 51 species, of which C. diphylla, two-leaved cassia, is a shrub with a round stem; two semi-orbiculate, obtuse, striated leaves on a short petiole; stipules covering the whole branches. It is an annual. Native of the West Indies. Some of the cassias are, however, very tall trees, as the C. fistula, Alexandrian purging cassia, cassia stick tree, or pudding pipe tree, which is 50 feet high, with a large trunk dividing into many branches. Native of both Indies. C. senna, Egyptian cassia, or senna, the plant which produces the leaves commonly known in medicine by the name of senna, is an annual: it rises with an upright branching stalk, a foot high. It grows naturally in Persia, Syria, and Arabia, whence the leaves are brought, dried, and picked from the stalks, to Alexandria in Egypt, and being thence annually imported into Europe, it has the title Alexandrian added to it.

CASSIDA, in natural history, a genus of Coleopterous insects, which, according to Linnæus, have moniliform antennæ, that become rather thicker towards the end: thorax and wing-cases with a broad margin, the former flat, and forming a kind of shield, beneath which the head is concealed. There are about 90 species.

The rotundate figure of the body, gibbous back, and flattened surface beneath, are a strong criterion of this genus. The surface above is commonly smooth, and in some species glossy; eyes oval, and placed near each other; antennæ inserted between the eyes: scutel triangular and small; wing-cases same length as the abdomen; legs short, thighs compressed, shanks rounded, and the tarsi consisting of four joints. Many of the species are very beautiful when alive, some of which retain their brilliancy of colours in the height of perfection after death; in others, however, and those especially of a small size, these are altogether evanescent, their rich metallic or golden hues fading as the insect dies, and totally disappearing in the dried specimens. Cassidæ immersed in spirit of wine alive are observed to retain the splendour of those golden hues for years in as high perfection as they appear in the living insect; but if taken out, and allowed to dry, these change colour in the same manner as the insect would in dying without being steeped in spirits. For immediate observation, the true colours of the living insect may how-

ever be revived in the dried specimens at any time, by leaving them for the space of 15 or 20 minutes in warm water; the colours reappearing while the insect is kept moist, and fading again as the insect dries.

The larvæ of the cassidæ are commonly found concealed on the under surface of the leaves of the plants on which they feed, and often hide themselves under a cover of their own excrements, which they support in the air above their bodies by means of their lateral spines, and the bristles at the extremity of their tail, to shelter themselves from the sun and rain. The larvæ cast their skins several times before they pass into the pupa state. The perfect female insect deposits the eggs in regular order on the leaves of plants, and covers them with excrements to conceal them. The common English name of the insects of this tribe is the tortoise beetle. We have only an inconsiderable number of the species indigenous to this country, and those only of a small size: many of the large kinds, and those distinguished for their vivid hues and colours, are natives of South America.

CASSINE, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx quinquepartite; petals five; berry trispermous. There are four species, of which C. Capensis, Cape cassine, or phillyrea, has a woody stalk, which in this country seldom rises more than six feet high, sending out many branches, covered with a purplish bark. The flowers are produced in roundish bunches from the side and at the end of the branches; they are white, and have five small petals spreading open; germ roundish, crowned by a bifid or trifid stigma. This shrub is a native of the Cape.

CASSINI (John Dominic), an eminent astronomer, was born of noble parents, at a town in Piedmont in Italy, June 8, 1625. After laying a proper foundation in his studies at home, he was sent to continue them in a college of Jesuits at Genoa. He had an uncommon turn for Latin poetry, which he exercised so very early, that some of his poems were published when he was but 11 years old. At length he met with books of astronomy, which he read with great eagerness. Pursuing the bent of his inclinations in this way, in a short time he made so amazing a progress, that in 1650 the senate of Bologna invited him to be their public mathematical professor. Cassini was but 25 years of age when he went to Bologna, where he taught mathematics, and made observations upon the heavens, with great care and assiduity. In 1652 a comet appeared, which he observed with great accuracy; and he discovered that comets were not bodies accidentally generated in the atmosphere, as had been supposed, but of the same nature, and probably governed by the same law as the planets. The same year he resolved an astronomical problem, which Kepler and Bulliald had given up as insolvable; *viz.* to determine geometrically the apogee and eccentricity of a planet, from its true and mean place. In 1653, when a church in Bologna was repaired and enlarged, he obtained leave of the senate to correct and settle a meridian line, which had been drawn by an astronomer in 1575. In 1657 he attended as an assistant to a nobleman, who was sent to Rome to compose some differences which had arisen between Bologna and Ferrara, from the inundations of the Po; and he shewed so much skill and judgment in the management of the affair, that in 1663 the Pope's brother appointed him inspector general of the fortifications of the castle of Urbino: and he had afterward committed to him the care of all the rivers in the ecclesiastical state.

In the mean time he did not neglect his astronomical studies, and made several discoveries relating to the planets Mars and Venus, particularly the revolution of Mars upon his own axis: but the point he had chiefly in view, was to settle an accurate theory of Jupiter's satellites; which, after much labour and observation, he happily effected, and published it at Rome, among other astronomical pieces, in 1666.

Picard, the French astronomer, getting Cassini's tables of Jupiter's satellites, found them so very exact, that he conceived the highest opinion of his skill; and from that time his fame increased so fast in France, that the government desired to have him a member of the academy. Cassini however could not leave his station without leave of his superiors; and therefore the king, Lewis the XIVth, requested of the Pope and the senate of Bologna, that Cassini might be permitted to come into France. Leave was granted for six years, and he came to Paris in the beginning of 1669, where he was immediately made the king's astronomer. When this term of six years was near expiring, the Pope and the senate of Bologna insisted upon his return, on pain of forfeiting his revenues and emoluments, which had hitherto been remitted to him:

but the minister Colbert prevailed on him to stay, and he was naturalized in 1673; the same year also in which he was married.

The Royal Observatory of Paris had been finished some time, and Cassini was appointed to be the first inhabiter; which he took possession of in September, 1671, when he set himself with fresh alacrity to attend the duties of his profession. In 1672 he endeavoured to determine the parallax of Mars and the Sun: and in 1677 he proved that the diurnal rotation of Jupiter round his axis was performed in 9 hours 58 minutes, from the motion of a spot in one of his larger belts: also in 1684 he discovered four satellites of Saturn, besides that which Huygens had found out. In 1693 he published a new edition of his "Tables of Jupiter's Satellites," corrected by later observations. In 1695 he took a journey to Bologna, to examine the meridian line which he had fixed there in 1655; and he showed, in the presence of eminent mathematicians, that it had not varied in the least during that 40 years. In 1700 he continued the meridian line through France, which Picard had begun, to the very southern limits of that country.

After our author had resided at the Royal Observatory for more than 40 years, making many excellent and useful discoveries, which he published from time to time, he died September the 14th, 1712, at 87 years of age; and was succeeded by his son James Cassini.

Cassini (James), a celebrated French astronomer, and member of the several Academies of Sciences of France, England, Prussia, and Bologna, was born at Paris February 18, 1677, being the younger son of John Dominic Cassini, above mentioned, whom he succeeded as astronomer at the Royal Observatory, the elder son having lost his life at the battle of La Hogue.

After his first studies in his father's house, in which it is not to be supposed that mathematics and astronomy were neglected, he was sent to study philosophy at the Mazarine college, where the celebrated Varignon was then professor of mathematics; from whose assistance young Cassini profited so well, that at 15 years of age he supported a mathematical thesis with great honour. At the age of 17 he was admitted a member of the Academy of Sciences; and the same year he accompanied his father in his journey to Italy, where he assisted him in the verification of the meridian at Bologna, and other measurements.

In 1712 he succeeded his father as astronomer royal at the Observatory. In 1717 he gave to the Academy his researches on the distance of the fixed stars, in which he showed that the whole annual orbit of near 200 millions of miles diameter, is but as a point in comparison of that distance. The same year he communicated also his discoveries concerning the inclination of the orbits of the satellites in general, and especially of those of Saturn's satellites and ring. In 1725 he undertook to determine the cause of the moon's libration, by which she shows sometimes a little towards one side, and sometimes a little on the other, of that half which is commonly behind or hid from our view.

In 1732 an important question in astronomy exercised the ingenuity of our author. His father had determined, by his observations, that the planet Venus revolved about her axis in the space of 23 hours: and M. Bianchini had published a work in 1729, in which he settled the period of the same revolution at 24 days 8 hours. From an examination of Bianchini's observations, which were upon the spots in Venus, he discovered that he had intermitted his observations for the space of three hours, from which cause he had probably mistaken new spots for the old ones, and so had been led into the mistake. He soon afterwards determined the nature and quantity of the acceleration of the motion of Jupiter, at half a second per year, and of that of the retardation of Saturn at two minutes per year; that these quantities would go on increasing for 2,000 years, and then would decrease again. In 1740 he published his "Astronomical Tables," and his "Elements of Astronomy;" which were very extensive and accurate works.

Although astronomy was the principal object of our author's consideration, he did not confine himself absolutely to that branch, but made occasional excursions into other fields. We owe also to him, for example, experiments on electricity, or the light produced by bodies by friction. Experiments on the recoil of fire arms; researches on the rise of the mercury in the barometer at different heights above the level of the sea; reflections on the perfecting of burning-glasses, and other memoirs.

After a long and laborious life, our author, James Cassini, lost his life by a fall in April, 1756, in the 80th year of his age, and

was succeeded in the Academy and Observatory by his second son, Cesar François de Thury; who also distinguished himself in the sciences connected with astronomy; and as well as his father and grandfather, published many valuable works. He died in 1784, of the small-pox, and was succeeded by his only son count John Dominic Cassini.

CASSIOPEIA, in astronomy, a constellation of the northern hemisphere, situated opposite to the Great Bear on the other side of the pole. See ASTRONOMY.

In the year 1572, a remarkable new star appeared in this constellation, surpassing Sirius or Lyra in brightness and magnitude. It appeared even bigger than Jupiter which, at that time, was near his perigee, and by some was thought equal to Venus, when she is in her greatest lustre; but in a month it began to diminish in lustre, and in about eighteen months entirely disappeared.

It alarmed all the astronomers of that age, many of whom wrote dissertations on it; among the rest Tycho Brahe, Kepler, Maurolycus, Lycetus, Gramineus, &c. Beza, the Landgrave of Hesse, Rosa, &c. wrote to prove it a comet, and the same which appeared to the Magi, at the birth of Jesus Christ, and that it came to declare his second coming: they were answered on this subject by Tycho. Several astronomers are of opinion that this star has a periodical return, which Keill and others have conjectured to happen every 150 years. Mr. Pigott adopts the same opinion; and he accounts for its not being noticed at the completion of every term, by its variable lustre at different periods, so that it may sometimes increase only to the 9th magnitude; and if this be the case, its period is probably much shorter.

CASSIUS, *precipitate of*, obtained from the muriate of gold by the means of tin. It is highly valued for the beauty of the colour which it gives to glass or enamel. It may be obtained by simply immersing a plate of tin in a dilute solution of muriate of gold: but the usual mode is to dissolve pure gold in a nitro-muriatic acid, compossed of three parts of nitric acid, and one of the muriatic. The tin is prepared by dissolving it, without heat, in an acid composed of two parts of nitric, and one of muriatic acid, previously diluted with an equal weight of water. This solution being saturated, is diluted with one hundred parts of water, to which the solution of gold in quantity equal to half the quantity of solution of tin is added: the liquor becomes of a beautiful purplish red colour, and a precipitate subsides which is to be washed and dried. This is the only preparation capable of giving a red colour to glass: which then serves as an imitation of the ruby.

CASSYTA, in botany, a genus of the Enneandria Monogynia class and order. Essential character: corol calycine, sexpartite; nectary of three truncate glands, surrounding the receptacle; interior filaments glanduliferous; drupe monospermous. There are but two species, of which C. filiformis is a plant which rises with taper succulent stalks, dividing into many slender succulent branches; these come out frequently by threes or fours at the same joint, afterward they send out side branches singly without order, and become very bushy; the flowers come out on the side of the branches, having no calyx; the corolla is oval, white, with a small tincture of red, opening like a navel at the top, including the germ, stamina, style, and nectareous glands so closely, as not to be discovered till the corolla is cut open. This plant grows naturally in both Indies.

CAST, among the Hindoos, denotes a tribe or number of families of the same rank and profession. There are in India four principal casts: the first is called the cast of "Brahmins," from the mouth or wisdom, and deemed the most sacred. These are to teach the principles of religion, to perform its functions, and to cultivate the sciences. They are the priests, the instructors, and philosophers of the nation. The second order called "Chehteree," from arms or strength; to draw the bow, to fight, to govern: these are entrusted with the government and defence of the state. The third order, called "Bice," from the belly, or nourishment, are to provide the necessaries of life by agriculture and traffic; these are composed of husbandmen and merchants. The fourth class denominated "Sooder," from the feet, or subjection; to labour, or serve, consisting of artisans, labourers, and servants. Besides these, there is a fifth class denominated "Burrun Sunker," supposed to be the illicit union between persons of different casts: they are most dealers in petty articles of retail trade.

CAST *iron*. See IRON.

CASTILLEIA, in botany, so named in memory of Castilleius, a botanist of Cadiz, a genus of the Didynamia Angiospermia

class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx tubular, compressed, upper lip bifid, lower none; corol lower, lip trifid, with two glands between the segments; capsules two-celled. There are two species, C. fissifolia and C. integrifolia, both natives of New Granada.

CASTING, in foundery, the running of a metal into a mould, prepared for that purpose. See FOUNDERY.

CASTING, a term used for the quitting or throwing aside any thing from the body of an animal, by an effort of nature. Thus deer cast their horns, snakes their skins, lobsters their shells, hawks their feathers annually. When birds cast their feathers it is called moulting. A horse casts his hair in the spring, and sometimes in the autumn also horses sometimes cast their hoofs.

CASTING *of drapery*, among painters, denotes the distribution of the folds; and the drapery is said to be well cast, when the folds are distributed in such a manner, as to appear rather the result of mere chance than of art, study, or labour. In that style of painting which is called "the grand," the folds of the draperies should be great, and as few as possible, because their rich simplicity is more susceptible of great lights. But it is an error to design draperies that are too heavy and cumbersome, for they ought to be suitable to the figures, with a combination of ease and grandeur. Order, contrast, and variety of stuffs and folds, constitute the elegance of draperies; and diversity of colours in those stuffs, contributes extremely to the harmony of the whole in historic compositions.

CASTLE, in the sea-language, is a part of the ship, of which there are two, the fore-castle, being the elevation at the prow, or the uppermost deck, towards the mizen, the place where the kitchens are. Hind-castle is the elevation which reigns on the stern over the last deck, where the officers cabins and places of assembly are.

CASTOR, the *beaver*, in natural history, a genus of Mammalia, of the order Glires. Generic character: upper fore-teeth truncated and hallowed in a transverse angle; lower transverse at the top; four grinders in each jaw; tail long, scaly, and depressed; clavicles perfect. There are two species, of which the most worthy of notice is C. fiber. The colour of the beaver is generally of a deep chesnut; sometimes it has been seen entirely white; less rarely completely black; it is about three feet long in the body; its tail is about the length of one foot, and by its peculiarity distinguishes this animal from every other quadruped; it is of an oval form, and flat, with a slight convexity towards the base, destitute of hair, and completely covered with scaly divisions. The beaver was known to the ancients for its possession of that sebacious matter called castor, secreted by two large glands near its genitals and anus, and of which each animal has about two ounces; but they appear to have been unacquainted with its habits and economy; with that mental contrivance and practical dexterity which, in its natural state, so strikingly distinguish it. Beavers are found in the most northern latitudes of Europe and Asia, but are most abundant in North America. In the months of June and July they assemble in large companies to the number of two hundred, on the banks of some water, and proceed to the formation of their establishment. If the water be subject to risings and fallings they erect a dam to preserve it at a constant level; where this level is naturally preserved this labour is superseded. The length of this dam is occasionally eight feet. In the preparation of it they begin with felling some very high, but not extremely thick, tree on the border of the river, which can be made to fall into the water; and, in a short time, this is effected by the united operation of many, with their fore-teeth, the branches being afterwards cleared by the same process. A multitude of smaller trees are found necessary to complete the fabric, and many of these are dragged from some distance by land and formed into stakes, the fixing of which is a work of extreme difficulty and perseverance, some of the beavers with their teeth raising their large ends against the cross-beam, while others at the bottom dig with their fore-feet the holes in which the points are to be sunk. A series of these stakes, in several rows, is established from one bank of the river to the other, in connection with the cross-tree, and the intervals between them are filled up by vast quantities of earth, brought from a distance, and plashed with materials adapted to give it tenacity and prevent its being carried off. The bark is formed at the bottom, of about the width of twelve feet, diminishing as it approaches the surface of the water to two or three; being thus judiciously constructed to resist its weight and efforts by the inclined plane instead of perpendicular opposition. These

preparations of such immense magnitude and toil being completed, they proceed to the construction of their mansions, which are raised on piles near the margin of the stream or lake, and have one opening from the land, and another by which they have instant access to the water. These building are usually of an orbicular form, in general about the diameter of ten feet, and comprehending frequently several stories. The foundation walls are nearly two feet in thickness, resting upon planks or stakes, which constitute also their floors. In the houses of one story only, the walls, which in all cases are plastered with extreme neatness both externally and within, after rising about two feet perpendicularly approach each other so as at length to constitute, in closing, a species of dome. In the application of the mortar to their habitations the tails as well as feet of the beavers are of essential service. Stone, wood, and a sandy kind of earth are employed in their structures, which by their compactness and strength completely preclude injury from winds and rain. The alder, poplar, and willow, are the principal trees which they employ; and they always begin their operations on the trunk at nearly two feet above the ground; nor do they ever desist from the process till its fall is completed. They sit instead of standing at this labour, and while reducing the tree to the ground derive a pleasure at once from the success of their toils, and from the gratification of their palate and appetite, by the bark which is a favourite species of food to them, as well as the young and tender parts of the wood itself.

For their support in winter ample stores are laid up near each separate cabin, and occasionally, to give variety and luxury to their repasts during a long season, in which their stores must have become dry and nearly tasteless, they will make excursions into the neighbouring woods for fresh supplies. Depredations by the tenants of one cabin on the magazines of another are unknown, and the strictest notions of property and honesty are universal. Some of their habitations will contain six only, others twelve, and some even 20 or 30 inhabitants; and the whole village or township contains in general about 12 or 14 habitations. Strangers are not permitted to intrude on the vicinity; but, amidst the different members of the society itself there appear to prevail that attachment and that friendship which are the natural result of mutual co-operation, and of active and successful struggles against difficulty. The approach of danger is announced by the violent striking of their tails against the surface of the water, which extends the alarm to a great distance; and, while some throw themselves for security into the water, others retire within the precincts of their cabins, where they are safe from every enemy but man.

The neatness as well as the security of their dwellings is remarkable, the floors being strewed over with box and fir, and displaying the most admirable cleanness and order. Their general position is that of sitting, the upper part of the body, with the head, being considerably raised, while the lower touches and is somewhat, indeed, immersed in the water. This element is not only indispensable to them in the same way as to other quadrupeds, but they carefully preserve access to it even when the ice is of very considerable depth, for the purpose of regaling themselves by excursions to a great extent under the frozen surface. The most general method of taking them is by attacking their cabins during these rambles, and watching their approach to a hole dug in the ice at a small distance, to which they are obliged, after a certain time, to resort for respiration.

The flesh of the anterior part of their bodies resembles that of land animals in substance and flavour, while that of the lower possesses the taste, and smell, and lightness of fish.

The sexual union among these animals is connected with considerable individual choice, sentiment, and constancy. Every couple pass together the autumn and winter with the most perfect comfort and affection. About the close of winter the females, after a gestation of four months, produce in general, each, two or three young, and soon after this period they are quitted by the males, who ramble into the country to enjoy the return of spring; occasionally returning to their cabins, but no longer dwelling in them. When the females have reared their young, which happens in the course of a few weeks, to a state in which they can follow their dams; these also quit their winter residence and resort to the woods to enjoy the opening bloom and renovated supplies of nature. If their habitations on the water should be impaired by floods, or winds, or enemies, the beavers assemble with great rapidity to repair the damage. If no alarm of this nature occurs, the sum-

mer is principally spent by them in the woods, and on the advance of autumn they assemble in the scene of their former labours and friendships, and prepare with assiduity for the confinement and rigours of approaching winter.

When taken young the beaver may be tamed without difficulty, but exhibits few or no indications of superior intelligence. Some beavers are averse to that association which so strikingly characterises these animals in general, and satisfy themselves with digging holes in the banks of rivers, instead of erecting elaborate habitations. The fur of these is comparatively of little value. See Mammalia, Plate VII. fig. 1.

C. huidobrius, or the Chilese beaver. This is found principally in the deep lakes and rivers of Chili. Its tail differs from that of the former, in being lanceolated and hairy. It produces no castor, and possesses nothing of the art of architecture. It is courageous, and even savage in its disposition, and has the power of remaining under water for a very considerable time. Its fur is employed in the manufacture of hats, and of a species of cloth as soft as the finest velvet.

CASTOR-*oil*, in pharmacy, is extracted from the kernel of the fruit produced by the Ricinus Americanus, or oil nut, which grows in many parts of America, and is much cultivated in Jamaica. A gallon of nuts from this tree will produce about a quart of oil. It is either prepared by coction or cold drawn; that is, extracted from the bruised seeds. It is sent over to us in barrels: and that is reckoned the best which has least colour.

CASTRAMETATION, is the art of measuring or tracing out the form of a camp on the ground; yet it sometimes has a more extensive signification, by including all the views and designs of a general; the one requires only the knowledge of a mathematician, the other the experience of an old soldier. The ancients were accustomed to fortify their camps by throwing up entrenchments round them. The Turks, and other Asiatic nations, fortify themselves, when in an open country, with their waggons and other carriages. The practice of the Europeans is quite different; for the surety of their camp consists in the facility and convenience of drawing out their troops at the head of their encampment; for which reason, whatever particular order of battle is regarded as the best disposition for fighting, it follows of course, that we should encamp in such a manner as to assemble and parade our troops in that order and disposition as soon as possible. It is therefore the order of battle that should regulate the order of encampment; that is to say, the post of each regiment in the line of battle should be at the head of its own encampment; from whence it follows, that the extent of the line of battle from right to left of the camp, should be equal to the front of the troops in line of battle, with the same intervals in the camp as in the line. By this means every battalion covers its own tents, and they can all lodge themselves, or turn out in case of necessity at a minute's warning.

If the front of the camp is greater than the line, the troops must leave large intervals, or expose their flanks; if less, the troops will not have room to form with the proper intervals.

The front or principal line of the camp is commonly directed to face the enemy.

CASUALS, a term used by military men, in their regimental returns of the British army, signifying men that are dead, have been discharged, or have deserted.

CASUARINA, in botany, a genus of the Monoecia Monandria class and order. Natural order of Coniferæ. Essential character: male calyx of the ament; corol scalelets two-parted; female calyx of the ament; corol none; style bifid; strobile. There are five species of which C. equisetifolia, horse-tail casuarina, is a very large spreading lofty tree; the leaves, or rather branchlets hanging down in bunches from twelve to eighteen inches in length, like very long hair, or a horse's tail, all jointed from top to bottom like the equisetums, or horse tails, is a very remarkable character of this singular tree. It is a native of the East Indies and the South Sea Islands.

CAT. See Felis.

Cat, a ship usually employed in the coal trade; built very strong, and made to carry from four to six hundred tons. It is distinguished by a narrow stern, projecting quarters, and by having no ornamental figure on the prows.

Cat-*hook*, a strong hook fitted to the cat, to hook the ring of the anchor when it is to be drawn up or catted.

Cat-*o'nine-tails*, an instrument, by which discipline is still maintained in the British navy and army, though to the honour of other countries, it is said that corporal punishment has been abolished. This instrument is composed of nine pieces of line or cord, about half a yard long, fixed upon a piece

of thick rope for a handle, and having three knots on each cord, with which the men who transgress the orders of their superiors are punished.

CAT's-*paw*, a light breeze of wind perceived at a distance in a calm, by the impression made on the surface of the sea, which it sweeps very lightly, and then decays. The same term is given to a particular turn made in the bight of a rope, in order to hook a tackle on it.

CAT-*harpings*, in a ship, small ropes running in little blocks from one side of the shrowds to the other, near the deck. Their use is to force the shrowds and make them taught, for the more security and safety of the masts.

CAT-*heads*, two strong beams of timber projected almost horizontally over the ships-bows, on each side of the bowsprit. The cat-head serves to suspend the anchor clear of the bow, when it is necessary to let it go: it is supported by a sort of knee, which is generally ornamented by sculpture.

CATACAUSTIC *curves*, in the higher geometry, that species of caustic curves which are formed by reflection.

These curves are generated after the following manner. If there be an infinite number of rays, as A B, A C, A D, &c. (plate Miscellanies, fig. 6.) proceeding from the radiating point A, and reflected at any given curve B D H, so that the angles of incidence be still equal to those of reflection; then the curve B E G, to which the reflected rays B I, C E, D F, &c. are tangents continually, as in the points I, E, F, is called the catacaustic curve.

If the reflected I B be produced to K, so that $AB = BK$, and the curve K L be the evolute of the catacaustic B E G, beginning at the point K; then the portion of the catacaustic $BE = AC - AB \times CE - BI$ continually. Or if any two incident rays, as A B, A C be taken, that portion of the caustic that is evolved while the ray A B approaches to a coincidence with A C, is equal to the difference of those incident rays × the difference of the reflected rays. When the given curve is a geometrical one, the catacaustic will be so too, and always rectifiable. The catacaustic of a circle is a cycloid, formed by the revolution of a circle along a circle. Thus, A B D, fig. 7, being a semicircle exposed to parallel rays; then those rays which fall near the axis C B will be reflected to F, the middle point of B C; and those which fall at A, as they touch the curve only, will not be reflected at all; but any intermediate ray H I will be reflected to a point K, somewhere between A and F. And since every different incident ray will have a different focal point, therefore those various focal points will form a curve line A E F in one quadrant, and F G D in the other, being the cycloid above-mentioned. And this figure may be beautifully exhibited experimentally by exposing the inside of a smooth bowl, or glass, to the sun beams, or strong candle light; for then this curve A E F G D will appear plainly delineated on any white surface placed horizontally within the same, or on the surface of milk contained in the bowl. The caustic of the common semi-cycloid; when the rays are parallel to the axis is also a common cycloid, described by the revolution of a circle upon the same base. The caustic of the logarithmic spiral is the same curve, only set in a different position.

CATACHRESIS, in rhetoric, a trope which borrows the name of one thing to express another. Thus Milton, describing Raphael's descent from the empyreal heaven to paradise, says,

"Down thither prone in flight
He speeds, and thro' the vast ethereal sky
Sails between worlds and worlds."

CATACOMB, a grotto or subterraneous place for the burial of the dead.

The term is particularly used in Italy, for a vast assemblage of subterraneous sepulchres, three leagues from Rome, in the Via Appia, supposed to be the sepulchres of the ancients. Others imagine these catacombs to be the cells wherein the primitive christians hid themselves. Each catacomb is three feet broad, and eight or ten high, running in form of an alley or gallery, and communicating with one another.

Mr. Monro, in the Philosophical Transactions, gives it as his opinion, that the catacombs were the burial places of the first Romans, before the practice of burning the dead was introduced; and that they were dug in consequence of these opinions, that shades hate the light, and love to hover about the place where their bodies were laid.

CATACOUSTICS, an appellation given to the doctrine of reflected sounds. See ACOUSTICS.

CATALOGUE, a list or enumeration of the names of several books, men, or other things, according to a certain order.

CATALOGUE *of the stars*, is a list of the

fixed stars, disposed in their several constellations, with the longitudes and latitudes of each.

The most renowned composers of these catalogues are, 1. Ptolemy, who added his own observations to those of Hipparchus Rhodius, about the year of Christ 880. 2. Ulugh Beigh made a catalogue of the fixed stars in 1437. 3. Tycho Brahe determined the places of 777 stars for the year 1600. 4. William, Landgrave of Hesse, with his mathematicians, determined the places of 400 fixed stars. 5. In the year 1667, Dr. Halley, in the island of St. Helena, observed 350 not visible in our horizon. And, 6. J. Hevelius, adding his own observations to those of the ancients, and of Dr. Halley, made a catalogue of 1888. But the last and greatest is the Britannic catalogue, a performance the most perfect of its kind, compiled from the observations of the accurate Mr. Flamstead, who, with all the talents and apparatus requisite for such an undertaking, devoted himself to that work for a long series of years. It contains 2934 stars.

In 1782, M. Bode, member of the Royal Academy of Sciences at Berlin, published a very extensive catalogue of the fixed stars, collected from the observations of Flamstead, Bradley, Hevelius, Tobias Mayer, De la Caille, Messier, La Mounier, D'Arquier, and other astronomers; in which the places of the stars, amounting in number to 5058, are given for the beginning of the year 1780. This catalogue, which is a very valuable work, though there is reason to apprehend that the same star is inserted more than once, is accompanied by a celestial atlas, or set of maps of the constellations, engraved in a very delicate and beautiful manner. In the catalogue already enumerated the stars are classed in constellations. In the following catalogues they succeed each other, according to the order in which they transit the meridian, without any regard to the constellation to which they belong: the name of the constellation being given with a description of the stars' situation in it. The first catalogue of the stars, as we conceive, that was printed in this form, or in the order of their right ascensions, is that of M. de la Caille, given at the beginning of his Ephemerides for the 10 years between 1755 and 1765, and printed in 1755. It contains the right ascensions and declinations of 307 stars, adapted to the beginning of the year 1750. In 1757 he published his "Astronomiæ Fundamenta," in which is a catalogue of the right ascensions and declinations of 398 stars, adapted likewise to the beginning of 1750. In 1763, the year immediately succeeding that of his death, the "Cœlum Australe Stelliferum" of the same author was published; and this contains a catalogue of the places of 1942 stars, all situated to the southward of the Tropic of Capricorn, and observed by the same indefatigable astronomer while he was at the Cape of Good Hope in 1751 and 1752. The places of these are given for the beginning of the year 1750. In the same year, the Ephemerides for the 10 years between 1765 and 1775, were published; in the introduction to which, the places of 515 zodaical stars are given, all deduced from his own observations. The stars in this catalogue are rectified to the beginning of the year 1765. The Nautical Almanac for 1773 contains a catalogue of 380 stars, in right ascension, declination, longitude, and latitude, derived from the observations of the late Rev. Dr. Bradley, and adjusted to the beginning of the year 1760. It has been since, *viz.* in 1798, republished with corrections by Dr. Hornsby, in the first volume of Bradley's Observations. These make but a small part of what might have been deduced from the labours of that great man, if his representatives had not withheld the rest from the public. Mr. Francis Wollaston informs us, that Dr. Bradley had the whole British catalogue calculated to the year 1744, and that traces may be observed in it of his having examined almost every star in it. He adds, from satisfactory information, that Dr. Bradley observed the British catalogue twice through: first, with the old instruments of the Royal Observatory, previous to 1750, and afterwards with the new ones. The 380 stars above mentioned were carefully rectified for the year 1790 by Mr. G. Gilpin.

At the end of the first volume of "Astronomical Observations, made at the Royal Observatory at Greenwich," published in 1776, Dr. Maskelyne, the present Astronomer Royal, has given a catalogue of 34 principal stars, in right ascension and north polar distance, adapted to the beginning of the year 1770, and which, being the result of several years' repeated obsesvations, made with the utmost care and the best instruments, may be presumed to be exceedingly accurate. In 1776 a work was published at Berlin, entitled "Recueil da Tebles Astronomiques," in which it contained a very large catalogue of stars from Hevelius, Flamsteed, M. de la Caille, and Dr. Bradley, with their latitudes and longitudes

for the beginning of 1800, with a catalogue of the southern stars of M. de la Caille, of double stars, of changeable stars, and of nebulous stars: a work very useful for the practical astronomer. To these may be added, Dr. Herschel's catalogue of double stars, printed in the Philosophical Transactions for 1782 and 1783; M. Messier's nebulæ and clusters of stars, published in the "Connoissance des Temps," for 1784; and Dr. Herschel's catalogue of the same kind, given in the "Philosophical Transactions" for 1786. In 1789, Mr. Francis Wollaston published in folio a "Specimen of a general Astronomical Catalogue, arranged in Zones of North Polar Distance, and adapted to January 1. 1790." In forming this catalogue, Mr. Wollaston has not made any use of those which precede Flamsteed, except in a small part that of Helvelius: but all the stars in the British catalogue of 1725 are inserted, as well as those which are in the three latter catalogues of M. de la Caille, those of Dr. Bradley in the Nautical Almanac for 1773; of M. Mayer; of Dr. Maskelyne; the double stars of Dr. Herschel; M. Messier's nebulæ; and all those of Dr. Herschel, excepting his second and third classes; that is, all those which are capable of being discerned with any telescopes inferior to his own. This work contains five distinct catalogues, *viz.* Dr. Maskelyne's new catalogue of 36 principal fixed stars; a general catalogue of all the stars in zones of north-polar distance; an index to the general catalogue; a catalogue of all the stars, in the order in which they pass the meridian; and a catalogue of zodiacal stars, in longitude and latitude.

CATANANCHE, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compound Flowers. Division, Semiflosculosæ. Cinarocephalæ, Jussieu. Essential character: receptacle chaffy; calyx imbricate; down awned from a five-bristled calycle. There are three species, of which C. *cærulea* puts forth many narrow hairy leaves, which are jagged on their edges like those of buckshorn plantain; but the leaves are broader, the jags deeper and at greater distances; these lie flat on the ground, turning their points upwards, which are very narrow. Between the leaves come out the flower stalks, which are in number proportionable to the size of the plant; for from an old thriving root, there is frequently eight or ten, and young plants do not send out more than two or three; each of the peduncles are terminated with single heads of flowers, having a dry, silvery, scaly calyx, in which are included three or four florets; these are of a fine blue colour, with a dark spot at bottom, and in each the stamens, with their yellow summits, standing a little above the petals, make a pretty appearance. It is a native of the South of Europe.

CATAPLASM, an external topical medicine, of a soft consistence, and prepared of ingredients of different virtues, according to the intention of the physician. See PHARMACY.

CATARACT, in medicine and surgery, a disorder of the humours in the eye, by which the pupilla, that ought to appear transparent and black, looks opaque, grey, blue, brown, &c. by which vision is variously impeded, or totally destroyed.

CATARRH. See MEDICINE.

CATASTASIS, in poetry, the third part of the ancient drama, being that wherein the intrigue, or action, set forth in the epitasis, is supported, and carried on, and heightened, till it be ripe for the unravelling in the catastrophe.

CATASTROPHE, in dramatic poetry, the fourth and last part in the ancient drama, or that immediately succeeding the catastasis; or, the fifth act in modern tragedy.

CATCH *word*, among printers, that placed at the bottom of each page; being always the first word of the following page.

CATECHU, in chemistry, a substance obtained by decoction, and inspissation from the wood of the mimosa catechu, a native of India, is a very powerful astringent, and contains a large proportion of tanning. It is almost wholly soluble in water, and in alcohol, but when acted upon by this, a portion of mucilage remains undissolved: the component parts are

Bombay catechu.

Tannin	54.5
Extractive matter	34.0
Mucilage	6.5
Residue	5
	100.0

Bengal catechu.

Tannin	48.5
Extract	36.5
Mucilage	8.0
Residue	7.
	100.0

CATEGORY, in logic, a series or order of all the predicates or attributes contained under any genus.

The school philosophers distribute all the objects of our thoughts and ideas into certain genera or classes, not so much, say they, to learn what they do not know, as to communicate a distinct notion of what they do know; and these classes the Greeks called categories, and the Latins predicaments.

Aristotle made ten categories; *viz.* substance, quantity, quality, relation, action, passion, time, place, situation, and habit; which are usually expressed by the following technical distich:

Arbor, sex, servos, ardore, refrigerat, ustos,
Ruri, cras, stabo, nec tunicatus ero.

CATENARIA, in the higher geometry, the name of a curve line formed by a rope hanging freely from two points of suspension, whether the points be horizontal or not. The nature of this curve was sought after in Galileo's time, but not discovered till the year 1690, when Mr. Bernoulli published it as a problem. Dr. Gregory, in 1697, published a method of investigation of the properties formerly discovered by Mr. Bernoulli and Mr. Leibnitz, together with some new properties of this curve. From him we take the following method of finding the general property of the catenaria.

1. Suppose a line heavy and flexible, the two extremes of which F and D, Plate II. Miscellanies, fig. 8, are firmly fixed in those points; by its weight it is bent into a certain curve F A D, which is called the catenaria.

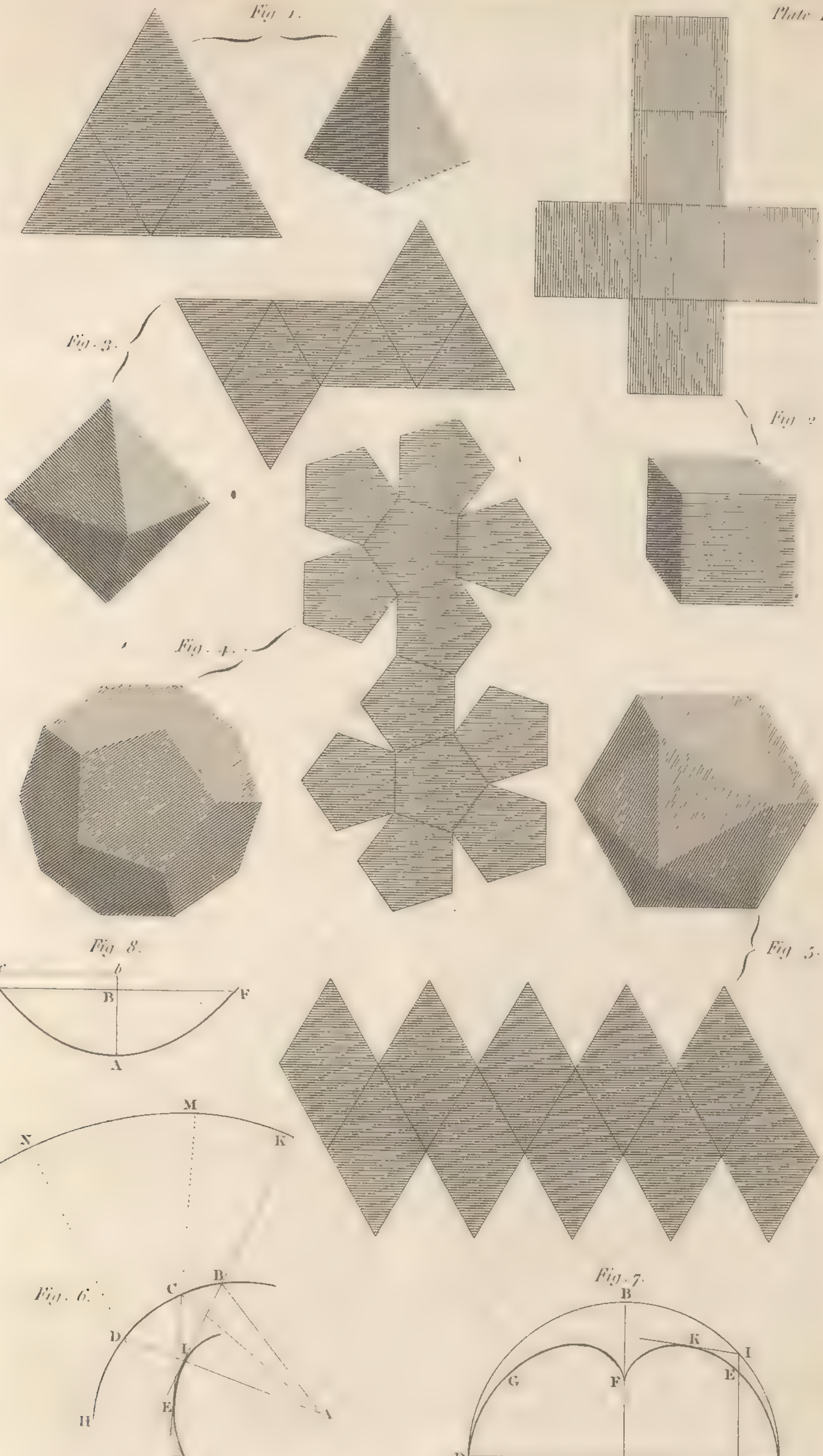
2. Let B D and $b\,c$ be parallel to the horizon, A B perpendicular to B D, and D c parallel to A B, and the points B b infinitely near to each other. From the laws of mechanics, any three powers in equilibrio, are to one another as the lines parallel to the lines of their direction, (or inclined in any given angle) and terminated by their mutual concourses: hence if D d express the absolute gravity of the particle D d, (as it will if we allow the chain to be every way uniform) then D c will express that part of the gravity that acts perpendicularly upon D d; and by the means of which this particle endeavours to reduce itself to a vertical position; so that if this lineola $d\,c$ be constant, the perpendicular action of gravity upon the parts of the chain will be constant too, and may therefore be expressed by any given right line. Further, the lineola D c will express the force which acts against that conatus of the particle D d, by which it endeavours to restore itself in a position perpendicular to the horizon, and hinders it from doing so. This force proceeds from the ponderous line D A drawing according to the direction D d; and is, *cæteris paribus*, proportional to the line D A which is the cause of it. Supposing the curve F A D, therefore, as before, whose vertex is A, axis A B, ordinate B D, fluxion of the axis D C = B b, fluxion of the ordinate $d\,c$, the relation of these two fluxions is thus; *viz.* $d\,c : \mathrm{D}\,d :: a : \mathrm{D\,A}$ curve, which is the fundamental property of the curve, and may be thus expressed (putting A B $= x$ and B D $= y$ and A D $= c$) $\dot{y} = \frac{a\,\dot{x}}{c}$.

CATERPILLAR, in natural history: the larvæ of butterflies are universally known by the name of caterpillars, and are extremely various in their forms and colours, some being smooth, others beset with either simple or ramified spines, and some are observed to protrude from their front, when disturbed, a pair of short tentacula or feelers, somewhat analagous to those of a snail. A caterpillar, when grown to its full size, retires to some convenient spot, and securing itself properly by a small quantity of silken filaments, either suspends itself by the tail, hanging with its head downwards, or else in an upright position, with the body fastened round the middle by a number of filaments. It then casts off caterpillar-skin, and commences chrysalis, in which state it continues till the butterfly is ready for birth, which liberating itself from the skin of the chrysalis, remains till its wings, which are first short, weak, and covered with moisture, are fully extended, this happens in about a quarter of an hour, when the animal suddenly quits the state of inactivity to which it had been so long confined, and becomes at pleasure an inhabitant of the air.

CATESBÆA, in botany, so called in honour of Mark Catesby, a genus of the Tetrandria Monogynia class and order. Natural order of Luridæ. Rubiaceæ, Jussieu. Essential character: corolla monopetalous, funnel-form, extremly long, superior; stamens within the mouth; berry polyspermous. There are but two species, of which C. spinosa, lily-thorn, rises with a branching stem to the height of twelve feet, covered with a pale russet bark; the branches

MISCELLANIES.

Plate II.



Lowry sculp.

London Published by Longman Hurst Rees & Orme May 1 1806

come out alternately from the bottom to the top, with small leaves resembling those of the box-tree, in clusters all round the branches at certain distances; the flowers come out single from the side of the branches, hanging downward, and are of a dull yellow colour; the berry is the size of a middling plum, hollow within, with small angular seeds. This shrub was discovered by Mr. Catesby near Nassau town, in Providence, one of the Bahama islands. C. parviflora is a native of Jamaica.

CATHARTICS, in medicine, are the same with what are commonly called purgatives. See MEDICINE.

CATHEDRAL, a church wherein is a bishop's see or seat.

After the establishment of Christianity, the emperors, and other great men, gave large demesnes and other possessions for the maintenance of the clergy, on these were built the first places of worship, which were called cathedra, cathedrals, sees, or seats, from the bishop and his chief clergy's residence thereon.

A cathedral was originally different from what it is now, the Christians, till the time of Constantine, having no liberty to build any temple. By their churches they only meant their assemblies; and by their cathedrals, nothing more than consistories.

CATHETER, in surgery, a fistulous instrument, usually made of silver, to be introduced into the bladder, in order to search for the stone, or discharge the urine when suppressed. See SURGERY.

CATHETUS, in geometry, a line or radius falling perpendicularly on another line or surface: thus the catheti of a right angled triangle are the two sides that include the right angle.

CATOPTRICS, that part of optics that treats of reflex vision, and explains the laws and properties of reflection, chiefly founded upon this truth, that the angle of reflection is always equal to the angle of incidence; and from thence deducing the magnitudes, shapes, and situations of the appearances of objects seen by the reflection of polished surfaces, and particularly plane, spherical, conical, and cylindrical ones. See OPTICS.

CATTLE. Under this term are comprehended horses and oxen, of both sexes and of all ages; these we term black cattle: while sheep, goats, &c. come under the designation of small cattle. The whole tribe are granivorous, and may be very easily maintained without the aid of the plough, though it is certain that the produce of tilled land will pay better when appropriated to the support of cattle, than common pastures, or even artificial grasses. The latter, such as clover, saintfoin, burnet, &c., are superior to common meadow hay, for the purposes of winter fodder; making the animals appear better in their coats, or hair, and causing them to fatten, and to endure fatigue, far beyond what they could undergo on common field grass, or its hay. We have thousands of cattle-markets, where beasts of all descriptions may be purchased, in every stage of condition, and in all their varieties. The great improvements made of late years in farming, added to our great increase of population, have rendered the business of feeding cattle of great importance.

CATTLE, *law relating to.* By a statute of Edward VI. no person shall buy any ox, &c., and sell the same again alive in the same market, or fair, on pain of forfeiting double the value thereof; half to the King, and half to him that shall sue. This is the act against forestalling, regrating, &c.

CATURUS, in botany, a genus of the Dioecia Triandria class and order. Natural order of Tricocceæ. Euphorbiæ, Jussieu. There are two species: C. spiciflorus is a tree about twenty feet in height, with many branches diffused all round; the wood is white and close, with a thick, dusky, unctuous, inodorous bark, and a yellow pith within; the fruit is a round, yellowish-green, insipid berry, inclosing one round green seed. Native of the East Indies. C. scandens is a native of the woods of Cochin-China.

CAVA, or VENA CAVA, in anatomy, a vein arising with a large sinus from the right auricle of the heart. See ANATOMY.

CAVALIER, in fortification, an elevation of earth, of different shapes, situated ordinarily in the gorge of a bastion, bordered with a parapet, and cut into more or less embrasures, according to the capacity of the cavalier.

CAVALRY, a body of soldiers that charge on horseback, and may properly be called the right arm of the army: they are of great service in disturbing the enemy by their frequent excursions, in intercepting convoys, and destroying the country. The cavalry is divided into squadrons, and encamp on the wings of the army.

CAUCALIS, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential cha-

racter: corolla radiated, in the disk; male, petals inflex-emarginate; fruit hispid with bristles; involucres entire. There are nine species. These plants are all annual, or at most biennial, and are seldom cultivated, except in botanic gardens. They will rise readily from seeds, where they are permitted to scatter, and will grow in any soil and situation.

CAVEAR, Caveer, or Caviary, the spawn, or hard roes of sturgeon, made into small cakes, an inch thick, and of an hand's breadth, salted and dried in the sun.

The French and Italians get the cavear from Archangel, but they seldom get it at the first hand, for they commonly buy it of the English and Dutch.

CAVEAT, in law, a kind of process in the spiritual courts to stop the proving of a will, the granting letters of administration, &c. to the prejudice of another. It is also used to stop the institution of a clerk to a benefice. A caveat stands in force for three months.

The entering a caveat being at the instance of the party, is for the benefit of the ordinary that he may do no wrong; it is a cautionary act for his better information, to which the temporal courts have no regard: therefore if after a caveat entered the ordinary should grant administration, or probate of a will, it is not void by our law, though it is by the canon law; but our law takes notice of a caveat.

CAVERNOSE, among anatomists, an appellation given to several parts of the body on account of their spongy structure: thus the cavernosa corpora are two spongy bodies, made up of a number of small caverns or cells.

CAVIA, the *cavy*, in natural history, a genus of Mammalia, of the order Glires. Generic character: two wedge-shaped front teeth; eight grinders; from four to five toes on the fore-feet, from three to five on the hind-feet; tail very short, or none; no clavicles. There are seven species, of which those that follow are most deserving attention.

C. cobaya, or the guinea pig. This animal is a native of South America, and found particularly in Brazil. It is tamed with great facility, and is inoffensive, timorous, and particularly cleanly; it does not, however, appear susceptible of strong attachments to its benefactors, nor is it remarkable for docility. It is one of the most prolific of animals, and Buffon calculates that, in 12 months only, 1000 might be produced from a single pair, as the female has been known to bring forth young when two months old only; and the time of gestation is only three weeks; and she will produce at least every two months. They are six or seven months before they arrive at their maturity of growth, but within the short period of twelve hours from their birth are nearly as alert and active as those fully grown, and therefore require parental assiduity only for a little time. Vegetables form their food, and on a great variety of these they will flourish and fatten: very succulent food of this description, however, is injurious, and, with sow-thistles and cabbage, should be employed for them nourishment of more consistency, such as grain and bread. They drink but little, appear, after eating, to ruminate, and are extremely apt to be affected by cold. They are in some places used as articles of food, and even considered as delicacies. They are uncommonly cleanly in their habitations, and are often to be seen smoothing and cleansing their fur with particular attention and perseverance. In contests they not only bite but kick. It is a curious circumstance, if it may be depended upon as true, and it is stated by authentic reporters, that the male and female seldom sleep at the same time, but exercise over each other alternate vigilance. See Mammalia, Plate VII. fig. 2.

C. paca, or the spotted cavy of Pennant, is clumsily formed: a native, like the former, of South America; is highly esteemed by the inhabitants of this quarter of the world for its food; is particularly fond of fruits and of sugar; and, continuing in its hole during the day, devotes the night to activity and refreshment. See Mammalia, Plate VII. fig. 3.

C. capybara, or the river cavy, inhabits particularly the eastern parts of South America; and when full grown weighs about a hundred pounds; it lives not only upon vegetables but also upon fish, which, as it swims and dives extremely well, it procures with facility, but which it brings to land before it devours; it is of a mild disposition and easily familiarised by man; its pursuit of prey is generally engaged in by night; it frequents, principally, marshes and the banks of rivers. These animals are reported to associate only in pairs. The female produces only one young at a time. Their flesh is praised by some as exquisite, but others represent it as rank and fishy.

C. aguti, the long-nosed cavy. These animals move like hares and grunt like pigs;

their food consists of various fruits, and of nuts, which they will hide and abstain from touching for many months; they breed with the rapidity of rabbits, no season checking their prolific tendencies; their flesh is very agreeable to the taste, and even when they are old, acquires little or no toughness. They are caught by the Indians in Guinea, and other warm parts of South America, where alone they are to be met with in great numbers, sometimes being hunted down by their dogs, and frequently being taken in traps to which they are allured by the accurate invitation of their peculiar sounds. They are nearly of the size of a hare; when pursued they retreat to burrows or holes of trees, which, indeed, constitute their irregular and frequently changed abodes, and in which they are almost uniformly found alone; or the female with its young ones. They hold their food in the same manner as the squirrel; they make their excursions for food during the day, and may be easily domesticated, though not so completely as to exclude altogether their natural wildness. See Mammalia, Plate VII. fig. 4.

CAUKING, or Caulking *of a ship*, is driving oakum, or the like, into all the seams of the plank of a ship, to prevent leaking and keep out the water.

Cauking *irons*, are iron chissels for that purpose. Some of these irons are broad, some round, and others grooved. After the seams are stopped with oakum it is done over with a mixture of tallow, pitch, and tar, as low as the ship draws water.

CAUL, in anatomy, a membranaceous part of the abdomen, covering the greatest part of the intestines.

CAULIFLOWERS, in gardening, a much esteemed species of *brassica*, or cabbage.

CAUSE, *causa*, that from whence any thing proceeds, or by virtue of which any thing is done: it stands opposed to effect. We get the ideas of cause and effect, says Mr. Locke, from our observation of the vicissitude of things, while we perceive some qualities or substances begin to exist, and that they receive their existence from the due application and operation of other beings. That which produces, is the cause, and that which is produced, the effect: thus, fluidity in wax is the effect of a certain degree of heat, which we observe to be constantly produced by the application of such heat.

Cause, *first*, that which acts of itself, and of its own proper power or virtue: God is the only first cause in this sense.

Causes, *second*, are those which derive the power and faculty of action from a first cause: these are improperly called causes, as they do not, strictly speaking, act at all, but are acted on: of this kind are all those that we term natural causes.

Causes, *final*, are the motives inducing an agent to act; or the design and purpose for which the thing was done.

Lord Bacon says that the final cause is so far from being serviceable, that it corrupts the sciences, unless it be restrained to human actions: however, continues he, final causes are not false, nor unworthy of inquiry in metaphysics: but their excursions into the limits of physical causes hath made a great devastation in that province; otherwise, when contained within their own bounds, they are not repugnant to physical causes.

CAUSEWAY, or Causey, a massive construction of stones, stakes, and fascines; or an elevation of earth, well beaten; serving either as a road in wet marshy places, or as a mole to retain the waters of a pond, or prevent a river from overflowing the lower grounds.

CAUSTIC, CAUSTICITY, a substance is said to be caustic when it produces the same effect on the tongue as that of actual fire, that is, an immediate sensation of burning, followed with a slight disorganization of the surface actually in contact. Thus alkalies are called caustic when deprived of carbonic acid, because when concentrated, they then burn and blister the tongue almost instantly. Caustic substances are also generally corrosive, or such as act upon organized matter, and decompose it with rapidity. The term caustic prefixed to the alkalies and earths to distinguish the pure or decarbonated state is now almost always omitted, as unnecessary by the use of the term carbonate, thus to the terms caustic potash, and mild potash are substituted those of potash, and carbonate of potash respectively. We also say lime, and the carbonate of lime. There is still some confusion with regard to the term soda among others; soda meaning in chemical language pure or caustic soda, but in commerce, and in common use the mild or carbonate of soda.

Caustic *lunar*, the old name for nitrate of silver, melted and cast into cylindrical pieces about the size of small black-lead pencils, for the use of surgeons: and the

solution of lunar-caustic is the proportion of from 8 to 12 grains in an ounce of water, and has been found an excellent remedy in cases of ring-worm, as it is called, that is, when the hair falls off in patches from the head.

CAUSTIC *curve,* in the higher geometry, a curve formed by the concourse or coincidence of the rays of light, reflected or refracted from some other curve. See CATACAUSTIC.

CAYENNE *pepper*. This is the levigated or ground pod of the plant commonly known to us by the name of capsicum. There are many varieties; but the principal are:—1. The berberry capsicum, much resembling that fruit in size and colour, though infinitely more glowing. It is perhaps the most pungent of all the vegetable simples with which we are acquainted. 2. The long-pod, which is extremely common, and generally grows as large as a man's middle finger. 3. The cockspur, which takes that name from its shape, and is highly pungent. 4. The caffree, which is round and wrinkled, and ordinarily about the size of a small medlar. All these may be raised from the seed on hot-beds, and be planted out in June. They are biennials in their native climate; *viz.* in Cayenne, whence the pepper derives its name, and in every part of the torrid zone; but we cannot keep them through the winter. Cayenne is esteemed a stimulant, and commonly has a place among the sauces, &c. intended for the table.

CAYS, a term used by sailors to denote the little islands and rocks that are almost every where dispersed among the West India islands.

CAZEMATE, or CASEMATE, in fortification, a certain retired platform in the flank of a bastion, for the defence of the moat and face of the opposite bastion.

CEANOTHUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: petals five, saccular, vaulted; berry dry, three-celled, three-seeded. There are six species, of which C. Americanus, American ceanothus, or New Jersey tea, seldom rises more than three or four feet high in England, sending out branches on every side from the ground upward. These branches are ornamented with oval pointed leaves, having three longitudinal veins running from the foot-stalk to the point, and diverging in the broad part of the leaves from each other; at the extremity of each shoot the flowers are produced in close thick spikes, and are composed of five small petals of a clear white. These appear in July, making a pretty appearance during their continuance; for as every shoot is terminated by one of these spikes, the whole shrub is covered over with flowers, the branches growing very close to each other, and when the autumn proves mild these shrubs often flower again in October.

CECROPIA, in botany, a genus of the Dioecia Diandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character, male; spathe caducous; ament imbricate, with turbinate scales, compressed-quadrangular; corolla none; female as in the male; germs imbricate; style one; stigma lacerated; berry one-seeded. There is but one species, *viz.* C. peltata, trumpet-tree, or snake-wood; this tree commonly rises to a considerable height, being seldom under forty feet in the most perfect state. The trunk and branches are hollow every where, and stopped from space to space with membranous septas, answering to so many light annular marks in the surface. The wood of this tree, when dry, is very apt to take fire by attrition: the native Indians always kindle their fires in the woods by rubbing a piece of it against some harder wood. The bark is strong and fibrous, and is frequently used for cordage. It is a native of South America, Jamaica, and other West India islands.

CEDAR, comprehended by Linnæus among the junipers. See JUNIPER. Cedar-wood, which is of a fragrant smell and fine grain, is almost incorruptible by reason of its bitterness, which renders it distasteful to worms. Historians tell us, that some of this timber was found in the temple of Apollo at Utica, 2000 years old. The cedars of Lebanon are famous, as having been used by Solomon in building the temple at Jerusalem.

CEDRELA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Miscellaneæ. Meliæ, Jussieu. Essential character: calyx withering; corolla five-petalled, funnel-form, fastened by the base to the receptacle to one-third of its length; capsule woody, five-celled, five-valved; seeds imbricate downwards, with a membranaceous wing. There is but one species; *viz.* C. odorata, Barbadoes bastard cedar; rises with a straight stem to the height of 70 or 80 feet: while young the bark is smooth, and of an ash colour; but as it advances, the bark becomes rough, and of

a darker colour. Toward the top it shoots out many side branches, garnished with winged leaves, composed of sixteen pair of leaflets, which are broad at their base, and are near two inches long, of a pale colour; these emit a rank odour in the summer season, so as to be very offensive. The fruit is oval, about the size of a partridge's egg, smooth, of a dark colour, and opens in five parts, having a five-cornered column standing in the middle, between the angles of which the winged seeds are closely placed, lapping over each other like the scales of fish. This tree is commonly known under the name of cedar in the British West India islands.

CEDROTA, in botany, a genus of the Octandria Monogynia class and order. Essential character: calyx six-parted; corolla none; germ superior, surrounded by a gland; style short. There is but one species; *viz.* C. Guianensis; this is a lofty tree, forty feet in height, and two in diameter, with a thick, unequal, wrinkled bark, full of clefts, and is a heavy aromatic wood, which becomes light when dry. It grows in the great forest of Guiana, flowering in May.

CELARENT, in logic, a mode of syllogism, wherein the major and conclusion are universal negative propositions, and the minor an universal affirmative. As

CE No man that is a hypocrite can be saved:
LA Every man who with his lips only cries Lord, Lord, is a hypocrite;
RENT Therefore, no man, who with his lips only cries Lord, Lord, can be saved.

CELASTRUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character; corolla five-petalled, spreading; capsule triangular, trilocular; seeds calyptrated. There are twenty-two species. This genus consists of shrubs or small trees, with alternate leaves, and the flowers many together, on axillary subdichotomous peduncles. They are mostly natives of America and the Cape of Good Hope.

CELERITY, the swiftness of any body in motion. See MECHANICS.

CELESTINE, in mineralogy, a species of the Strontian genus: it is divided by Werner into two sub-species; *viz.* the fibrous and the foliated: the colour of the former is intermediate between indigo blue and bluish grey, and sometimes passes into a milk white. It loses its colour in keeping. It is found massive and in plates, also crystallized: the fragments are splintery. It shows a tendency to prismatic distinct concretions, which appear to be parallel and conformable with the fibrous fracture. Specific gravity is 3.83. Its geognostic situation is very imperfectly known; it is imagined to occur in marl. It is found in France, and at Frankstown in Pennsylvania. The foliated celestine is milk white, which falls into blue: it occurs massive, and is crystallized in six-sided tables that intersect one another. It is found in Sicily, and in England, near Bristol: specific gravity 3.6, nearly, and the constituent parts are, according to Vauquelin,

Sulphate of strontian	91.42
Carbonate of lime	8.33
Oxide of iron	0.25
	100.00

CELLEPORA, in natural history, a genus of the vermes zoophyta. Animal an hydra or polype; coral somewhat membranaceous, composed of round cells. There are eight species, of which we shall notice C. ramulosa, which is found in the Northern Ocean, very brittle and much branched, and appearing as if composed of grains of sand. C. spongites has rows of tubular top-shaped cells, in single layers, the openings of which are margined. This species inhabits the Mediterranean and North seas: white, grey, or red, and marked on the under side of the cells with lines between each row; they are from two to five inches in diameter.

CELLULAR *substance*, in anatomy, or CELLULAR *membrane*, is the medium which connects and supports all the various parts and structures of the body. It is composed of an assemblage of fibres, and laminæ of animal matter; connected to each other, so as to form innumerable cells, or small cavities, from which its name of cellular is derived. This substance pervades every part of the animal structure. By joining together the minute fibrils of muscle, tendons or nerve, it forms obvious and visible fibres; it collects these fibres into larger fasciculi; and by joining such fasciculi to each other, constitutes an entire muscle or nerve. It thus forms an investment common to the whole muscle, and bestows on each bundle of fibres, nay, on each fibre, down to the most minute threads, peculiar sheaths, delicate and tender in proportion to the subtilty of the fibre. It joins together the individual muscles, and is collected

in their intervals. It surrounds each vessel and nerve in the body; often connecting these parts to each other by a firm kind of capsule; and in a looser form joining them to the neighbouring muscles, &c. When condensed into a firm and compact structure, it constitutes the various membranes of the body; which, by long maceration in water, may be resolved into a cellular texture. Its general condensation on the surface of the body constitutes the cutis, or true skin. In the bones, it forms the basis and ground-work of their fabric; a receptacle, in the interstices of which the earth of bone is deposited. The only parts of the body in which the cellular texture seems to be wanting, are the proper substance of the brain, the crystalline lens, enamel of the teeth, and the insensible integuments of the body; *viz.* the epidermis, nails, and hair. As the cellular substance is entirely soluble in boiling water, it is ascribed by chemists to the peculiar modification of animal matter, termed gelatine. Its watery solution assumes, when cold, the appearance of jelly, and, after a particular mode of preparation, constitutes glue.

From the universal extent of this cellular texture, two conclusions may be drawn. 1. It forms the basis of the whole animal fabric, in such a way that, if we conceive every part removed, except this, the form of the whole would still be expressed in cellular substance. 2. It forms a connection and passage between all parts of the body, however remote in situation, or dissimilar in structure. For the cells of this substance every where communicate; as we may collect from facts of the most common and familiar occurrence. The air in emphysema spreads rapidly from the chest to the most remote parts of the body; it has been known in such a case to gain admission into the eye-ball.

CELOSIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Miscellaneæ. Amaranthi, Jussieu. Essential character; calyx three-leaved; leaflets similar to those of the five-petalled corolla; stamina conjoined at the base to the plaited nectary; capsule gaping horizontally. There are fourteen species. Celosias, or cocks' combs, are all herbaceous plants, and annual. The flowers are glomerate in spikes or panicles, some of which are flated and shaped somewhat like the comb of a cock. Natives of the East Indies, China, Cochin China, and Japan.

CELSIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: calyx five-parted; corolla rotated; filament bearded; capsule two-celled. There are four species. Natives of the Levant, Crete, the East Indies, and Peru.

CELTIS, in botany, English *lote* or *nettle tree*, a genus of the Polygamia Monoecia class and order. Natural order of Scabridæ. Amentaceæ, Jussieu. Essential character: Herm. calyx five-parted; corolla none; stamina five; styles two; drupe one-seeded; male, calyx six-parted; corolla none; stamnia six. There are seven species, of which C. australis, European nettle tree, or lote tree, with a black fruit, is about fifty feet in height, with slender branches, which have a smooth dark coloured bark, with grey spots. The fruit is the size of a pea; it grows naturally in the south of France, where it is one of the largest trees. The wood of this tree is exceedingly hard, and when it arrives to any size, its hardness, toughness, and flexibility, entitle it to very important services. Its fine regular spreading head, of a cheerful green colour, renders this tree very proper for clumps in parks, groves, single trees, or avenues.

CEMENT *copper*. The copper procured from the sulphate by precipitation with iron is so called.

CEMENTATION, in the arts, a general method of forming steel from iron, by means of the application of charcoal. In a proper furnace layers of bars of malleable iron, and layers of charcoal are placed one upon another, the air excluded, the fire is raised to a great height, and kept up for eight or ten days. If after this the conversion of the iron into steel be complete, the fire is extinguished, and the whole is left to cool for six or eight days longer. Iron prepared in this manner is named blistered steel, from the blisters which appear on its surface. Copper is converted into brass by cementation with a powder of calamine and charcoal. The powder thus used is called cement powder.

CEMENTS and *lutes*. Under this article may be mentioned the receipts for preparing some of the most useful substances of this kind, that are required in common chemical operations. The uses of lutes and cements are either to close the joinings of chemical vessels to prevent the escape of vapours and gases during the processes of distillation, sublimation, and the like, or to protect vessels from the action of the fire, which might crack, or fuse, or

calcine them; or sometimes to repair flaws and cracks, and for a variety of other smaller purposes.

From the vast variety of receipts for lutes and cements of different kinds, the following may be selected, which will answer most of the purposes of the experimental chemist. To prevent the escape of the vapours of water, spirit, and liquors not corrosive, the simple application of slips of moistened bladder will answer very well for glass, and paper with good paste for metal. Bladder, to be very adhesive, should be soaked some time in water moderately warm, till it feels clammy, it then sticks very well: if smeared with white of egg, instead of water, it adheres still closer. Another very convenient lute is linseed meal, moistened with water to a proper consistence, well beaten, and applied pretty thick over the joinings of the vessels. This immediately renders them tight, and the lute in some hours dries to a hard mass. Almond paste will answer the same purpose. The use of the above lute is so extensive, that no other is required in closing glass vessels in preparing all common distilled liquors; and it will even keep in ammonia, and acid gasses, for a longer time than is required for most experimental purposes. It begins to scorch and spoil at a heat much above boiling, and therefore will not do as a fire-lute. It is still firmer, and dries sooner when made up with milk, or lime water, or weak glue. A number of very cohesive cements impervious to water and most liquids and vapours, and extremely hard when once solidified, are made by the union of quick-lime with many of the vegetable or animal mucilaginous liquors. The variety of these is endless. We may first mention the following, as it has been extensively employed by chemists for centuries. Take some whites of eggs with as much water, beat them well together, and sprinkle in sufficient slaked lime, to make up the whole to the consistence of thin paste. The lime should be slaked by being once dipped in water, and then suffered to fall into powder, which it will do speedily with great emission of heat, if well burnt. This cement should be spread on slips of cloth, and applied immediately, as it hardens or sets very speedily. While hardening, it may be of use to sprinkle over it some of the lime in fine powder. This cement is often more simply, and as conveniently managed, by smearing slips of linen on both sides with white of egg, and when applied to the joining of the vessels, shaking some powdered lime over it: it then dries very speedily. Another lute of the same kind, and equally good, is made by using a strong solution of glue to the lime, instead of the white of egg: it sets equally soon, and becomes very hard. A mixture of liquid glue, white of egg, and lime, makes the *lut d'ane*, which is so firm, that broken vessels united with it are almost as strong as when sound. None of these lutes, however, will enable these vessels to hold liquids for any great length of time. Milk or starch, with lime, make a good but less firm lute. A very firm and singular lute of this kind is made by rubbing down some of the poorest skimmed-milk cheese with water, to the consistence of thick soup, and then adding lime, and applying as above: it answers extremely well. Lime and blood, with a small quantity of brick-dust, or broken pottery, stirred in, is used in some places as a very good water-cement, for cellars and places liable to damp.

All the above-mentioned cements, with lime, become very hard by drying, insomuch that they cannot be separated from glass vessels without the help of a sharp knife and some violence; and hence delicate vessels and long thin tubes, cemented with it, are apt to break when the apparatus is taken down, and sometimes even by the mere force of contraction in setting. It is a great advantage, however, that they may be applied immediately to any accidental crack or failure of the lute already on, notwithstanding a stream of vapour is bursting through; and in large distillations it is of advantage always to have some of the materials at hand.

CENCHRUS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Grasses. Essential character: invol. laciniate, echinate, two-flowered; calyx glume two-flowered, one male, the other hermaphrodite; Herm.. corolla glume awnless; stamina three; seed one; male corolla glume awnless; stamina three. There are eleven species, all natives of both Indies.

CENSOR *of books*, are a body of doctors or others established in divers countries to examine all books before they go to the press, and to see they contain nothing contrary to faith and good manners.

In England, we had formerly an officer of this kind, under the title of licenser of the press; but since the revolution, our press has been laid under no such restraint.

CENT, in commerce, an abridgment of centum, is used to express the profit or loss arising from the sale of any commodity. Thus we say, there is 10 *per cent.* profit, or 10 *per cent.* loss; which is $\frac{1}{10}$ profit, or $\frac{1}{10}$ loss, upon the sale of the whole.

CENTAUREA, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of compound flowers. Cinarocephalæ, Jussieu. There are seventy-seven species, of which we shall only mention C. moschata, purple sweet centaury, which is an annual, and has been many years propagated in the English gardens, under the title of Sultan flower, or sweet Sultan. It was brought from the Levant, where it grows naturally in arable land among the corn; it sends up a round, channelled stalk, nearly three feet high, which divides into many branches, from the sides of which come out long naked peduncles, each sustaining a single head of flowers; they have a strong odour, so as to be very offensive to many people; they are purple, white, or flesh-coloured; there is also a variety with fistula flowers, and another with fringed flowers; but these degenerate in a few years, however carefully the seeds may be saved.

CENTER, or CENTRE, in geometry, a point equally distant from the extremities of a line, figure, or body.

CENTER *of a circle,* a point in the middle of a circle, or circular figure, from which all lines drawn to the circumference are equal.

CENTER *of a conic section,* a point wherein the diameters intersect each other. In the ellipsis, this point is within the figure, and in the hyperbola, without.

CENTER *of a curve of the higher kind,* the point where two diameters concur. When all the diameters concur in the same point, Sir Isaac Newton calls it the general center.

CENTER *of an ellipsis,* the point where the transverse and conjugate diameters intersect each other.

CENTER *of gravitation and attraction,* in physics, that point to which the revolving planet or comet is impelled or attracted by the impetus of gravity.

CENTER *of gravity,* in mechanics, that point about which all the parts of a body do, in any situation, exactly balance each other. Hence, 1. If a body be suspended by this point as the center of motion, it will remain at rest in any position indifferently. 2. If a body be suspended in any other point it can rest only in two positions, *viz.* when the said center of gravity is exactly above or below the point of suspension. 3. When the center of gravity is supported the whole body is kept from falling. 4. Because this point has a constant endeavour to descend to the center of the earth; therefore, 5. When the point is at liberty to descend the whole body must also descend, either by sliding, rolling, or tumbling down. 6. The center of gravity in regular uniform and homogeneal bodies, as squares, circles, &c. is the middle point in a line connecting any two opposite points or angles; wherefore, if such a line be bisected the point of section will be the center of gravity.

To find the center of gravity of a triangle. Let BG (Plate III. Miscell. fig. 1,) bisect the base A C of the triangle A B C, it will also bisect every other line D E drawn parallel to the base, consequently the center of gravity of the triangle will be found somewhere in the line B G. The area of the triangle may be considered as consisting of an infinite number of indefinitely small parallelograms, D, E, *b*, *a*, each of which is to be considered as a weight, and also as the fluxion of the area of the triangle, and so may be expressed by $2y\dot{x}$, (putting $BF = x$, and $FE = y$) if this fluxionary weight be multiplied by its velocity x, we shall have $2yx\dot{x}$ for its momentum. Now put $BG = a$ and $AC = b$, then $BG\ (a) : AC\ (b) :: BF\ (x) : DE = \frac{bx}{a} = 2y$, therefore the fluxion of the weights $2y\dot{x} = \frac{bx\dot{x}}{a}$; and the fluxion of the momenta $2yx\dot{x} = \frac{bxx\dot{x}}{a}$, whence the fluent of the latter, *viz.* $\frac{bx^3}{3a}$ divided by the fluent of the former, *viz.* $\frac{bx^2}{2a}$ will give $\frac{2}{3}x$ for the distance of the point from B in the line B F, which has a velocity equal to the mean velocity of all the particles in the triangle D B E, and is therefore its center of gravity. Consequently the center of gravity of any triangle A B C, is distant from the vertex B $\frac{2}{3}$ B G a right line drawn from the angle B bisecting the base A C. And since the section of a superficial or hollow cone is a triangle, and circles have the same ratio as their diameters, it follows that the circle whose plane passes through the center of gravity of the cone, is $\frac{2}{3}$ of the length of the side distant from the vertex of the said cone.

To find the center of gravity of a solid

cone. As the cone consists of an infinite number of circular areas, which may be considered as so many weights, the center of gravity may be found as before, by putting B E $= x$ (fig. 2) B G $= a$, the circular area D F E $= y$, and A G C $= b$; and from the nature of the cone, $a^2 : x^2 :: b : y = \frac{b\,x^2}{a^2}$: but $\dot{x}\,y = \frac{bx^2\dot{x}}{a^2} =$ fluxion of the weights; and $y\,x\,\dot{x} = \frac{b\,x^3\,\dot{x}}{a^2} =$ fluxion of the momenta, whence the fluent of the latter, *viz.* $\frac{b\,x^4}{4\,a^2}$ divided by the fluent of the former $\frac{b\,x^3}{3\,a^2}$ will give $\frac{3}{4}x$ for the center of gravity of the part D B E F, consequently the center of gravity of the cone A B C G is distant from the vertex B $\frac{3}{4}$ of the side B G, in a circle parallel to the base.

To find the center of gravity in a parallelogram and parallelopiped, draw the diagonal A D and E G (fig. 3,) likewise C B and H F; since each diagonal A D and C B divides the pallelogram A C D B into two equal parts, each passes through the center of gravity; consequently the point of intersection, I, must be the center of gravity of the parallelogram. In like manner, since both the plane C B F H and A D G E divide the parallelopiped into two equal parts, each passes through its center of gravity, so that the common intersection I K is the diameter of gravity, the middle whereof is the center. After the same manner may the centre of gravity be found in prisms and cylinders, it being the middle point of the right line that joins the center of gravity of their opposite bases.

The center of a gravity of a parabola is found as in the triangle and cone. Thus, let B F in the parabola A B C (fig. 4) be equal to x, D E $= y$, then will $y\,\dot{x}$ be the fluxionary weight, and $y\,x\,\dot{x}$ the fluxion of the momenta; but from the nature of the curve we have $y = x^{\frac{1}{2}}$; whence $y\,\dot{x} = x^{\frac{1}{2}}\,\dot{x}$, and $y\,x\,\dot{x} = x^{\frac{1}{2}}\,\dot{x}\,x$, whose fluent $\frac{2}{5}\,x^{\frac{5}{2}}$ divided $\frac{2}{3}\,x^{\frac{3}{2}}$ the fluent of $x^{\frac{1}{2}}\,\dot{x}$ will give $\frac{3}{5}\,x = \frac{3}{5}$ B F for the distance of the center of gravity from the vertex B in the part of D B E; and so $\frac{3}{5}$ of B G is that center in the axis of the whole parabola A B C from the vertex B.

The center of gravity in the human body is situated in that part which is called the pelvis, or in the middle between the hips. For the center of gravity of segments, parabolic, conoids, spheroids, &c. we refer to Wolfius.

Center *of gravity of two or more bodies*, a point so situated in a right line joining the centers of these bodies, that if this point be suspended the bodies will equiponderate and rest in any situation. In two equal bodies it is at equal distances from both: when the bodies are unequal it is nearer to the greater body, in proportion as it is greater than the other; or the distances from the centers are inversely as the bodies. Let A (fig. 5,) be greater than B, join A B, upon which take the point C, so that C A : C B :: B : A, or that A $\times$ C A $=$ B $\times$ C B; then is C the center of gravity of the bodies A and B. If the center of gravity of three bodies be required, first find C the center of gravity of A and B; and supposing a body to be placed there equal to the sum of A and B, find G the center of gravity of it and D; then shall G be the center of gravity of the three bodies A, B, and D. In like manner the center of gravity of any number of bodies is determined.

The sum of the products that arise by multiplying the bodies by their respective distances, from a right line or plane given in position, is equal to the product of the sum of the bodies multiplied by the distance of the center of gravity from the same right line or plane, when all the bodies are on the same side of it: but when some of them are on the opposite side, their products, when multiplied by their respective distances from it, are to be considered as negative, or to be subducted. Let I L (fig. 6,) be the right line given in position, C the center of gravity of the bodies A and B; A a, B b, C c, perpendiculars to I L in the points a, b, and c; then if the bodies A and B be on the same side of I L we shall find $A \times Aa + b \times Bb = \overline{A + B} \times Cc$. For drawing through C, the right line M N parallel to I L meeting A a in M, and B b in N, we have A : B :: B C : A C by the property of the center of gravity, and consequently A : B :: B N : A M, or $A \times AM = B \times BN$; but $A \times Aa + B \times Bb = A \times Cc + A \times AM + B \times Cc - B \times BN = A \times Cc + B \times Cc = \overline{A + B} \times Cc$. When B is on the other side of the right line I L (fig. 7,) and C on the same side with A, then $A \times Aa - B \times Bb = A \times Cc + A \times AM - B \times BN + B \times Cc = \overline{A + B} \times Cc$; and when the sum of the products of the bodies on one side of I L multiplied by their distances from it, is equal to the sum of the products of the bodies multiplied by their

distances on the other side of I L, then C c vanishes, or the common center of gravity of all the bodies falls on the right line I L.

Hence it is demonstrable that when any number of bodies move in right lines with uniform motions, their common center of gravity moves likewise in a right line with an uniform motion; and that the sum of their motions estimated in any given direction, is precisely the same as if all the bodies in one mass were carried on with the direction and motion of their common center of gravity.

Center *of an hyperbola*, a point in the middle of the transverse axis.

Center *of magnitude*, of any homogeneal body, the same with the center of gravity.

Center *of motion*, that point which remains at rest, while all the other parts of a body move about it. And this is the same in uniform bodies of the same matter throughout, as the center of gravity.

Center *of oscillation*, that point in a pendulum in which, if the weight of the several parts thereof were collected, each vibration would be performed in the same time as when those weights are separate. This is the point from whence the length of a pendulum is measured, which in our latitude, in a pendulum that swings seconds, is 39 inches and $\frac{2}{10}$.

The center of suspension is the point on which the pendulum hangs.

A general rule for finding the center of oscillation. If several bodies be fixed to an inflexible rod suspended upon a point, and each body be multiplied by the square of its distance from the point of suspension, and then each body be multiplied by its distance from the same point; and all the former products when added together, be divided by all the latter products added together, the quotient which shall arise from thence, will be the distance of the center of oscillation of these bodies from the said point.

Thus, if C F (fig. 8) be a rod on which are fixed the bodies A, B, D, &c. at the several points A, B, D, &c. and if the body A be multiplied by the square of the distance C A, and B be multiplied by the square of the distance C B, and so on for the rest; and then if the body A be multiplied by the distance C A, and B be multiplied by the distance C B, and so on for the rest; and if the sum of the products arising in the former case be divided by the sum of those which arise in the latter, the quotient will give C Q, the distance of the center of oscillation of the bodies A, B, D, &c. from the point C. To determine the center of oscillation of the rectangle R I H S (fig. 9) suspended on the middle point A of the side R I, and oscillating about its axis R I. Let R I $=$ S H $= a$, A P $= x$, then will P p, $= d\,x$ and the element or the area, consequently one weight $= a\,d\,x$ and its momentum $a\,x\,d\,x$. Wherefore $s\,a\,x^2\,d\,x$: $s\,a\,x\,d\,x = \frac{1}{3}\,a\,x^3 : \frac{1}{2}\,a\,x^2 = \frac{2}{3}\,x$, indefinitely expresses the distance of the center of oscillation from the axis of oscillation in the segment R C D I. If then for x be substituted the altitude of the whole rectangle R S $= b$, the distance of the center of oscillation from the axis will be found $= \frac{2}{3}\,b$.

The center of oscillation in an equilateral triangle S A H oscillating about its axis R I, parallel to the base S H, is found at a distance from the vertex A equal to $\frac{3}{4}$ A E the altitude of the triangle.

The center of oscillation in an equilateral triangle S A H oscillating about its base S H, is found at a distance from the vertex A $= \frac{1}{2}$ A E.

For the centers of oscillation of parabolas and curves of the like kind oscillating about their axis parallel to their bases, they are found as follows. In the apollonian parabola, the distance of the center of oscillation from the axis $= \frac{5}{7}$ A E.

In the cubical paraboloid, the distance of the center from the axis $\frac{7}{10}$ A E. In a biquadratic paraboloid, the distance of the center from the axis $= \frac{9}{13}$ A E.

Center *of percussion*, in a moving body, that point wherein the striking force is greatest, or that point with which if the body strikes against any obstacle, no shock shall be felt at the point of suspension.

The center of percussion, when the striking body revolves round a fixed point, is the same with the center of oscillation, and consequently may be determined by the same rule.

Hence a stick of a cylindrical figure, supposing the center of motion at the hand, will strike the greatest blow at a distance about two-thirds of its length from the hand.

The center of percussion is the same with the center of gravity, if all the parts of the striking body be carried with a parallel motion, or with the same celerity.

Center *of a parallelogram*, or *polygon*, the point in which its diagonals intersect.

Center *of a sphere*, a point in the middle, from which all lines drawn to the sur-

face are equal. Hermes Trismegistus defines God an intellectual sphere, whose center is every where, and circumference no where.

CENTINEL or CENTRY, in military language, is a private soldier, from the guard posted upon any spot of ground, to stand and watch carefully for the security of the said guard, or of any body of troops, or post, and to prevent any surprise from the enemy. All centinels are to be very vigilant on their posts; neither are they to sing, smoke, or suffer any noise to be made near them. They are not to sit down, lay their arms out of their hands, or sleep; but keep moving about their posts during the two hours they stand, if the weather will allow of it. No centry to move more than 50 paces to the right, and as many to the left of his post, and let the weather be ever so bad, he must not get under any other cover but that of the centry-box. No one to be allowed to go from his post without leave from his commanding officer; and, to prevent desertion or marauding, the centries and vedettes must be charged to let no soldier pass.

CENTRAL *forces*, the powers which cause a moving body to tend towards, or recede from, the center of motion.

If a body A (plate III. Miscel. fig. 10,) be suspended at the end of a string A C, moveable about a point C, as a center, and in that position it receive an impulse in an horizontal direction, it will be thereby compelled to describe a circle about the central point. While the circular motion continues, the body will certainly endeavour to recede from the center, which is called its centrifugal force, and arises from the horizontal impetus. With this force it acts upon the fixed center-pin, and that, by its immobility, re-acts with an equal force on the body, by means of the string, and solicits it towards the center of motion; whence it is called the centripetal force; and when we speak of either or both indefinitely, they are called the central forces of the revolving body.

The doctrine of central forces makes a considerable branch of the Newtonian philosophy, and has been greatly cultivated by mathematicians, on account of its extensive use in the theory of gravity, and other physical and mathematical sciences.

In this doctrine it is supposed that matter is equally indifferent to motion or rest; or that a body at rest never moves itself, and that a body in motion never of itself changes either the velocity or the direction of its motion; but that every motion would continue uniformly, and its direction rectilinear, unless some external force or resistance should affect it, or act upon it. Hence, when a body at rest always tends to move, or when the velocity of any rectilinear motion is continually accelerated or retarded, or when the direction of a motion is continually changed, and a curve line is thereby described, it is supposed that these circumstances proceed from the influence of some power that acts incessantly; which power may be measured, in the first case, by the pressure of the quiescent body against the obstacle which prevents it from moving, or by the velocity gained or lost in the second case, or by the flexure of the curve described in the third case: due regard being had to the time in which these effects are produced, and other circumstances, according to the principles of mechanics. Now the power or force of gravity produces effects of each these kinds, which fall under our constant observation near the surface of the earth: for the same power which renders bodies heavy, while they are at rest, accelerates their motion when they descend perpendicularly; and bends the track of the motion into a curve line, when they are projected in a direction oblique to that of their gravity. But we can judge of the forces or powers that act on the celestial bodies by effects of the last kind only. And hence it is, that the doctrine of central forces is of so much use in the theory of the planetary motions.

Sir Isaac Newton has treated of central forces in his Principia, and has demonstrated this fundamental theorem, *viz.* that the areas which revolving bodies describe by radii drawn to an immoveable center, lie in the same immoveable planes, and are proportional to the times in which they are described.

The theory of this species of motion is comprised in the following propositions. 1. When two or more bodies revolve at equal distances from the center of the circle they describe, but with unequal velocities, the central forces necessary to retain them will be to each other as the squares of their velocities. That is, if one revolves twice as fast as the other, it will require four times the retaining force the other does; if with three times the velocity, it will require nine times the force to retain it in its orb, &c.

2. When two or more bodies move with equal velocities, but at unequal distances from the center they revolve about, their central forces must be inversely as their

distances. That is, by how many times greater the distance a body revolves at is from the center, so many times less force will retain it.

3. When two or more bodies perform their revolutions in equal times, but at different distances from the centre they revolve about, the forces requisite to retain them in their orbs will be to each other as the distance they revolve at from the center: for instance, if one revolves at twice the distance the other does, it will require a double force to retain it, &c.

4. When two or more bodies revolving at different distances from the center are retained by equal centripetal forces, their velocities will be such, that their periodical times will be to each other as the square roots of their distances. That is, if one revolves at four times the distance another does, it will perform a revolution in twice the time that the other does; if at nine times the distance, it will revolve in thrice the time.

5. And, in general, whatever be the distances, the velocities, or the periodical times of the revolving bodies, the retaining forces will be to each other in a ratio compounded of their distances directly, and the squares of their periodical times inversely. Thus, for instance, if one revolves at twice the distance another does, and is three times as long in moving round, it will require two-ninths, that is, two-ninths of the retaining power the other does.

6. If several bodies revolve at different distances from one common center, and the retaining power lodged in that center decrease as the squares of the distances increase, the squares of the periodical times of these bodies will be to each other as the cubes of their distances from the common center. That is, if there be two bodies whose distances, when cubed, are double or treble, &c. of each other, then the periodical times will be such, as that when squared only they shall also be double, or treble, &c.

7. If a body be turned out of its rectilineal course by virtue of a central force, which decreases as you go from the seat thereof, as the squares of the distances increase; that is, which is inversely as the square of the distance, the figure that body shall describe, if not a circle, will be a parabola, an ellipsis, or an hyperbola; and one of the foci of the figure will be at the seat of the retaining power. That is, if there be not that exact adjustment between the projectile force of the body and the central power necessary to cause it to describe a circle, it will then describe one of those other figures, one of whose foci will be where the seat of the retaining power is.

8. If the force of the central power decreases as the square of the distance increases, and several bodies revolving about the same describe orbits that are elliptical, the squares of the periodical times of these bodies will be to each other as the cubes of their mean distances from the seat of that power.

9. If the retaining power decrease something faster as you go from the seat thereof (or which is the same thing, increase something faster as you come towards it) than in the proportion mentioned in the last proposition, and the orbit the revolving body describes be not a circle, the axis of that figure will turn the same way the body revolves; but if the said power decrease (or increase) somewhat slower than in that proportion, the axis of the figure will turn the contrary way. Thus, if a revolving body, as D, (fig. 11) passing from A towards B describe the figure A D B, whose axis A B at first points as in the figure, and the power whereby it is retained decrease faster than the square of the distance increases, after a number of revolutions, the axis of the figure will point towards P, and after that towards R, &c. revolving round the same way with the body; and if the retaining power decrease slower than in that proportion, the axis will turn the other way.

Thus it is the heavenly bodies, *viz.* the planets, both primary and secondary, and also the comets, perform their respective revolutions. The figures in which the primary planets and the comets revolve are ellipses, one of whose foci is at the sun: the areas they describe, by lines drawn to the center of the sun, are in each proportional to the times in which they are described. The squares of their periodical times are as the cubes of their mean distances from the sun. The secondary planets describe also circles or ellipses, one of whose foci is in the center of their primary ones, &c.

From what has been said may be deduced the velocity and periodic time of a body revolving in a circle, at any given distance from the earth's center, by means of its own gravity. Put $g = 16\frac{1}{12}$ feet, the space described by gravity, at the surface, in the first second of time, *viz.* $=$ A M; then, putting $r =$ the radius A C; it is $AE = \sqrt{AB \times AM} = \sqrt{2gr}$ the velocity in a circle at its surface in one second of time; and hence, putting $c =$

3.14159 &c. the circumference of the earth being $2cr = 25{,}000$ miles, or 132,000,000 feet, it will be $\sqrt{2gr} : 2cr :: 1'' : c\sqrt{\frac{2r}{g}} =$ 5078 seconds nearly, or $1^h\ 24^m\ 38^s$, the periodic time at the circumference: also the velocity there, or $\sqrt{2gr}$ is $= 26{,}000$ feet per second nearly. Then, since the force of gravity varies in the inverse duplicate ratio of the distance, by the rules laid down, it is $\sqrt{R} : \sqrt{r} :: v$ or $26{,}000 : 26{,}000\sqrt{\frac{r}{R}} =$ V, the velocity of a body revolving about the earth at the distance R; and $\sqrt{r^3} : \sqrt{R^3} :: t$, or $5078'' : 5078\sqrt{\frac{R^3}{r^3}} = T$, the time of revolution in the same. So if, for instance, it be the moon revolving about the earth at the distance of 60 semi-diameters; then $R = 60\,r$, and the above expressions become $V = 26{,}000\sqrt{\frac{1}{60}} = 3357$ feet per second, or $38\frac{1}{7}$ miles per minute, for the velocity of the moon in her orbit; and $T = 5078\sqrt{\frac{R^3}{r^3}} = 2{,}360{,}051$ seconds, or $27\frac{3}{10}$ days nearly, for the periodic time of the moon in her orbit at that distance.

Thus also the ratio of the forces of gravitation of the moon towards the sun and earth may be estimated. For one year, or $365\frac{1}{4}$ days, being the periodic time of the earth and moon about the sun, and $27\frac{3}{10}$ days the periodic time of the moon about the earth, also 60 being the distance of the moon from the earth, and 23,920 the distance from the sun, in semidiameters of the earth, it is

$$\frac{60}{27.3^2} : \frac{23920}{365.25^2} :: f \text{ or } 1 : \frac{23902}{60} \times \frac{27.3^2}{365.25^2}$$

$= 2\frac{2}{9}$; that is, the proportion of the moon's gravitation towards the sun is to that towards the earth as $2\frac{2}{9}$ to 1 nearly.

Again, we may hence compute the centrifugal force of a body at the equator, arising from the earth's rotation. For, the periodic time when the centrifugal force is equal to the force of gravity, it has been shown above, is 5078 seconds; and 23 hours, 56 minutes, or 86,160 seconds, is the period of the earth's rotation on its axis; therefore, as $86{,}160^2 : 5078^2 :: 1 : \frac{1}{289}$, the centrifugal force required, which therefore is the 289th part of gravity at the earth's surface. See Simpson's Fluxions, vol. i.

Central *rule*, a rule discovered by Mr. Thomas Baker, whereby to find the center of a circle designed to cut the parabola in as many points, as an equation to be constructed hath real roots. Its principal use is in the construction of equations, and he has applied it with good success as far as biquadratics.

The central rule is chiefly founded on the property of the parabola, that if a line be inscribed in that curve perpendicular to any diameter, a rectangle formed of the segments of the inscript is equal to the rectangle of the intercepted diameter and parameter of the axis.

The central rule has the advantage over Des Cartes and De Latere's methods of constructing equations, in that both these are subject to the trouble of preparing the equation, by taking away the second term.

CENTRIFUGAL *force*, that force by which all bodies that move round any other body in a curve endeavour to fly off from the axis of their motion in a tangent to the periphery of the curve, and that in every point of it.

Mr. Huygens demonstrates, that this force is always proportional to the circumference of the curve in which the revolving body is carried round. The centrifugal force of any body is to the centripetal as the square of the arch which a body describes in a given time, divided by the diameter, to the space through which a heavy body moves in falling from a place where it was at rest in the same time.

If any body swim in a medium heavier than itself, the centrifugal force is the difference between the specific weight of the medium and the floating body.

All moving bodies endeavour after a rectilinear motion, because it is the easiest, shortest, and most simple: whenever therefore they move in any curve, there must be something that draws them from their rectilinear motion, and detains them in their orbits; and were that force to cease, the moving body would go straight off in a tangent to the curve in that very point, and so would get still further and further from the focus, or center of its curvilinear motion.

It may be, that in a curve where the force of gravity in the describing body is continually variable, the centrifugal force may also continually vary in the same manner, and so that one may also supply the defect, or abate for the excess of the other, and consequently the effect be every where equal to the absolute gravity of the revolving body.

Centrifugal *Machine*, a curious machine, for raising water by means of a centrifugal force, combined with the pres-

sure of the atmosphere. This machine consists of a large tube of copper, &c. in the form of a cross, placed perpendicularly in the water, and resting at the bottom on a pivot. At the upper part of the tube is an horizontal cog-wheel, which touches the cogs of another in a vertical position; so that by the aid of a double winch, the whole machine is moved round with very great velocity. Near the bottom of the perpendicular part of the tube is a valve opening upwards; and near the two extremities, but on the contrary sides of the arms, or cross part of the tube, are two other valves opening outwards. These two valves are kept shut, by means of springs, till the machine is put in motion; when the centrifugal velocity of the water forces them open, and discharges itself into a cistern or reservoir placed there for that purpose. On the upper part of the arm are two holes, which are closed by pieces that screw into the metal of the tube. Before the machine can work, these holes must be opened, and water poured in through them, till the whole tube be full: by these means all the air will be forced out of the machine, and the water supported in the tube by means of the valve at the bottom. The tube being thus filled with water, and the holes closed by their screw-caps, it is turned round by the winch; when the water in the arms of the tube acquires a centrifugal force, opens the valves near the extremities of the arms, and flies out with a velocity nearly equal to that of the extremities of the said arms.

If the men who work the machine be supposed to turn the winch round in three seconds, the machine will move round its axis in one second; and, consequently, each extremity of the arms will move with a velocity of 18.8 feet in a second. A column of water, therefore, of three inches diameter, will issue through each of the valves with a velocity of 18.8 feet in a second; but the area of the aperture of each of the valves is 7.14 inches; which, being multiplied by the velocity in inches $=$ 125.6, gives 1610.784 cubic inches, the quantity of water discharged through one of the apertures in one second; so that tbe whole quantity discharged in that space of time through both the apertures is $=$ 3221.568 inches; or 193294.08 cubic inches in one minute. But 60812 cubic inches make a tun, beer-measure; consequently, if we suppose the centrifugal machine to revolve round its axis in one second, it will raise nearly 3 tuns 44 gallons in one minute; but this velocity is too great, at least to be maintained for any considerable time: so that, when this and other deficiencies in the machine are allowed for, two tuns are nearly the quantity that can be raised by it in one minute. As the water is forced up the perpendicular tube by the pressure of the atmosphere, it is evident that this machine cannot raise water above 32 feet high.

CENTRIPETAL *force*, that force by which a body is every where impelled, or any how tends towards some point as a center; such is gravity, or that force whereby bodies tend towards the center of the earth; magnetical attraction, whereby the loadstone draws iron; and that force, whatever it be, whereby the planets are continually drawn back from right-lined motions, and made to move in curves.

The greater the quantity of matter in any body is, the greater will be its centripetal force, all things else alike. If a body laid upon a plane revolve at the same time, and about the same center with that plane, and so describe a circle; and if the centripetal force, wherewith the body is drawn every moment towards the center, should cease to act, and the plane should continue to move with the same velocity, the body will begin to recede from the center about which the plane moved. See CENTRAL *forces*.

CENTRISCUS, in natural history, a genus of fishes, ranked among the branchiostegous order of Linnæus, but by Dr. Shaw among the Cartilagenei. Generic character: snout lengthened; body compressed, carinated beneath; ventral fins united. There are but three species; *viz.* the scutatus, scolopax, and the velitaris. All are found in the Indian seas, and the scolopax is likewise a native of the Mediterranean.

CENTROGASTER, in natural history, a genus of fishes of the order Thoracici. Generic character: head compressed, smooth; gill-membraned, mostly seven rayed; body depressed, smooth; fins spinous; ventral connected by a membrane, with four sharp spines, and six soft rays. There are four species.

CENTUNCULUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rotaceæ. Lysimachiæ, Jussieu. Essential character: calyx four-cleft; corol four-cleft, spreading; stamina short; capsules one-celled, opening horizontally. There is but one species, *viz.* C. minimus, bastard pimpernel, is an an-

nual, and a native of Italy, France, Germany, and Denmark—with us on Hounslow-heath, Ashford-common, near Hampton Court, Chiselhurst, &c. It flowers from June to August.

CEPHAELIS, in botany, a genus of the Pentandria Monogynia class and order: flowers in heads, involucred; corol tubular; stigma two-parted; berry two-seeded; receptacle chaffy. There are 12 species: found chiefly in the West Indies.

CEPHALANTHUS, in botany, *button wood, button tree*, or *pond dogwood*, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Rubiaceæ, Jussieu. Essential character: calyx common, none; proper superior, funnel form; receptacle globular, naked; seed one, lanuginous. There are five species, of which C. occidentalis, American button wood, is a shrub, which in this country is seldom higher than seven feet. The branches come out by pairs opposite at each joint: the ends of which are terminated by loose spikes of spherical heads, about the size of a marble, each of which is composed of many small flowers, of a whitish yellow colour, fastened to an axis in the middle; these appear in July, and in warm seasons, are succeeded by seeds, which sometimes ripen.

CEPHALIC *medicines* are remedies for disorders of the head.

CEPHALOPHORA, in botany, a genus of the Syngenesia Æqualis class and order: receptacle chaffy-fleshy; down simple; calyx ovate, imbricate. One species found in Guinea.

CEPHEUS, in astronomy, a constellation of the northern hemisphere. See Astronomy.

CEPOLA, in natural history, the *band-fish*, a genus of fishes of the order Thoracici. Generic character: head short; teeth curved, sharp; body very long and compressed; abdomen extremely short; gill membrane, six-rayed. There are three species according to Gmelin, *viz*. 1. C. tænia, or silvery band-fish, with red fins, very obtuse head, and attenuated tail. This fish swims with great rapidity, and presents a beautiful spectacle by the undulating flexures of its body. It lives on the smaller kind of crabs, and shell-fish; and as it frequents the shores, it is often used as a bait for other fishes. 2. C. rubescens, reddish band fish; and 3. C. Trachyptera: both natives of the Mediterranean. Dr. Shaw mentions another species, *viz*. C. Hermanniæna.

CERAMBYX, in natural history, a genus of insects of the order Coleoptera. Antennæ setaceous; feelers four; thorax spinous or gibbous; shells linear. Of this very beautiful and finely variegated family, many hundred species have, by naturalists, been noticed and described. They have separated them into four divisions, *viz*. A. feelers equal, filiform; the subdivisions in this class are, *a*. jaw cyclindrical entire; in some the thorax has moveable spines, in others the thorax is margined; *b*. jaw obtuse, one-toothed; *c*. jaw bifid, horny; *d*. jaw bifid, membranaceous; thorax unarmed. B. feelers equal, capitate; thorax spinous. C. feelers equal, clavate; thorax unarmed. D. feelers unequal, the two fore-ones filiform, the hind-ones clavate. The larvæ of this genus resemble soft, oblong, slender worms, with a scaly head and six hard legs on the fore part: they bore through the inner part of trees, pulverizing the wood, and are transformed into perfect insects in the cavities which they make: many of them diffuse a strong smell, perceivable at a great distance; and some when taken utter a sort of cry, produced by the friction of the thorax on the upper part of the abdomen and shells. The antennæ are deemed short when they are shorter than the body; moderate when of equal length with the body; and long when they exceed the body. In the division C. the species violaceus, so called from the colour of its body, is found chiefly in fir timber which has been felled some time, and which has not been stripped of its bark: it bores serpentine cavities between the bark and the wood, which are larger in diameter as the insect increases in size, filling the space it leaves behind with its excrement, which resembles saw dust.

CERASTIUM, in botany, English *mouse-ear*, or *mouse-ear chickweed*, a genus of the Decandria Pentagynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals bifid; capsules unilocular, gaping at the tip. There are eighteen species. None of the mouse-ear chickweeds make much appearance, and are therefore only cultivated in botanic gardens. Some of them are common weeds in most parts of Europe; the smoother sorts are not disagreeable to cattle; the seeds are useful to birds.

CERATE. See Pharmacy and Wax.

CERATOCARPUS, in botany, a genus of the Monoecia Monandria class and order. Natural order of Holoraceæ. Atrip-

lices, Jussieu. Essential character: male, calyx one-leafed, bifid; corol none; female calyx one-leafed, keeled, permanent, two-horned; styles two; seeds single, compressed, inclosed in and covered by the calyx. There is but one species, *viz.* C. arenarius, is an annual, branching plant, with very narrow leaves. Three male flowers sessile in each division of the stems; females solitary, sessile in each axilla of the leaves. It has no proper pericarp, but the calyx when ripe becomes a sort of oblong-triangular compressed sheath, with a ridge on each side, and two innocuous spines, diverging almost horizontally at the end. Within this is a single obovate seed, compressed, and at bottom very sharp-pointed, which does not drop from its covering. Native of Tartary.

CERATONIA, in botany, English *carob tree, St. John's bread*, a genus of the Polygamia Trioecia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: hermaphrodite; calyx five-parted; corol none; stamens five; style filiform; legume coriaceous; many seeded; dioecous; male and female separate. There is but one species, *viz.* C. siliqua. The carob tree, which is a native of Syria, Palestine, Egypt, Cyprus, Candia, Sicily, Apulia, Spain, &c.

CERATOPETALUM, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted, permanent, bearing the stamina; petals five, pinnatifid; antheræ spurred, capsule covered in the bottom of the calyx; two-celled, one species, a native of New Holland.

CERATOPHYLLUM, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: male calyx many-parted; corola none; stamens sixteen to twenty; female calyx many-parted; corolla none; pistils one; style none; seed one, naked. There are two species, *viz.* C. demersum; prickly-seeded hornwort; and C. submersum; smooth-seeded hornwort. They grow in ditches and slow streams, flowering in August and September in Europe; also in Japan. It is common in Jamaica, called there morass weed, and used to cover fish, &c. when carried to any distance.

CERBERA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; drupe one-seeded. There are five species, of which C. ahouai, oval-leafed cerbera, grows naturally in the Brazils, and also in the Spanish West Indies in plenty; and there are some of the trees growing in the British Islands of America. This tree is about ten feet high, sending out many crooked diffused branches, which toward the top has thick succulent leaves about three inches long and near two broad, of a lucid green colour, full of a milky juice, as is every part of the tree. The flowers come out in loose bunches at the end of the branches; they are of a cream colour. It flowers in July, but never produces fruit in England. The wood of this tree is exceedingly offensive, and the kernels of the nuts are a most deadly poison.

CERCARIA, in natural history, a genus of the Vermes infusoria: worm invisible to the naked eye, pellucid, and furnished with a tail. There are 13 species, of which C. gyrinus is round with a sharp pointed tail; found in animal infusions; white, gelatinous, fore-part nearly globular. C. catellus; body three-parted, with a forked tail; is met with in waters where flowers have been kept; head moveable, affixed to the body by a point; abdomen not so wide, but twice as long as the head, and filled with intestines; tail shorter than the head and narrower than the abdomen, ending in two bristles, which it can unite and separate at pleasure; C. mutabilis; changeable, cylindrical, red or green, with a pointed slightly bifid tail; found in stagnant pools in such innumerable myriads, as to cover the whole surface with a sheet of green or red, giving it sometimes the appearance of being tinged with blood; varies its posture from a long cylindrical body, larger in the middle, to a nearly globular one; the extremities are pellucid.

CERCIS, in botany, English *Judas tree*, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-toothed, gibbous below; corol papilionaceous; standard short, beneath the wings; legume. There are two species, *viz.* C. siliquastrum, common Judas-tree; and C. canadensis, Canada Judas tree, or red budding tree. These trees are usually planted with other flowering trees, for ornaments to pleasure gardens, and for their singular beauty deserve a place as as well as most other sorts. The wood is also beautifully veined with black and green, and taking a fine polish, may be converted to many uses.

Fig.1. Acarus *autumnalis : harvest bug* . *Fig.2.* A *siro : cheese mite* *Fig.3.* Aphis *ulmi* . Apis *mellifica : common bee* . *Fig. 5. queen* . *Fig. 6. drone* *Fig.7* Aranea *diadema : garden spider* . *Fig.8.* A. *tarantula : tarantula spider* . *Fig. 9.* Buprestis *gigantea* . *Fig.10.* Byrrhus *musæorum* . *Fig.11.* Cerambyx *coriarius*.

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CEREBELLUM, in anatomy, the hinder part of the brain. See ANATOMY.

CEREBRUM, in anatomy, denotes the brain. See ANATOMY.

CEREMONIES, *master of the*, an officer instituted by King James I. for the more honourable reception of ambassadors and strangers of quality; he wears about his neck a chain of gold, with a medal with the crown of Great Britain, having on one side an emblem of peace, with the motto, *Beati pacifici;* and on the other, an emblem of war, with *Dieu et mon droit*; his salary is three hundred pounds *per annum*.

CERINTHE, in botany, English *honeywort*, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: border of the corolla tube-bellied; throat pervious; seeds two, bilocular. There are two species, of which C. major, great honeywort, is about eighteen inches high, round, smooth, branching, and leafy. Leaves glaucous, becoming blue by age, without prickles, but ciliated about the edge, dotted with white. The tube of the corolla is yellow, but the border is purple; the toothlets very short and revolute. C. minor, small honeywort, is very nearly allied to the foregoing; the corolla five-cleft to one-third of the length, whereas that is only five-lobed at the edge. Annual when sown in the spring, but biennial when sown in autumn. Both these plants are natives of France, Italy, Switzerland, and Germany.

CERITE. See CERIUM.

CERIUM, in chemistry, a new metal obtained from a fossil found in Sweden, to which has been given the name of Cerite. This fossil occurs disseminated or massive; it is of a flesh red colour, more or less deep, with sometimes a shade of yellow: it is semi-transparent: its fresh fracture has considerable lustre. It strikes fire with steel with difficulty: is not attracted by the magnet: its specific gravity is from 4.7 to 4.9. Exposed to a strong heat it does not melt, but loses 5 or 6 per cent. of weight, becomes friable, and acquires a bright yellow colour. With borax it forms a globule, greenish while hot, but colourless when cold. From 100 parts of it, the Swedish chemists obtained about 50 of oxide of cerium, 22 oxide of iron, 23 silex, and 5.5 carbonate of lime. According to Vauquelin's analysis, the proportions are oxide of cerium 63, silex 17.5, oxide of iron 2, lime from 3 to 4, water 12. The pure oxide of cerium is extracted from the cerite, by dissolving this mineral in nitro-muriatic acid, and, after saturating the clear solution with an alkali, precipitating by tartrate of potash. The precipitate well washed, calcined, and digested in vinegar, is the oxide of cerium.

The oxide of cerium exists in different degrees of oxidizement. When precipitated from its acid solutions by the alkalis, it is white, but acquires a shade of yellow when dried in the air, and, when exposed to a continued heat, becomes of a brick red colour. The white, according to Vauquelin, is the one at the lower degree of oxidizement; but the difference in the proportion of oxygen is, he remarks, inconsiderable. Neither of them can be fused by heat. Borax determines their fusion: the globule, heated by the exterior flame of the blow-pipe, is of a blood-red colour, which, by cooling, becomes of a yellowish green, and, at length, colourless and transparent; or, if the proportion of oxide has been large, opaque and pearly.

The metal itself, in the trials which Vauquelin made with it, proved insoluble in any unmixed acid, and was dissolved with great difficulty in nitro-muriatic acid. Its oxide, however, combines with the acids easily, and the properties of its salts have been fully determined.

CEROPEGIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, erect; seeds plumose; border of the corolla converging. There are six species, of which C. candelabrum is a twining plant, with slender stems, round, green, or reddish, leaves opposite, ovate, thick, soft, and smooth. The peduncle, and at first the flowers, hang down, but when open they erect themselves, and, being placed in a circle, have the appearance of a set of lamps suspended. The follicles or seed-vessels hang down. It is a native of the East Indies.

CERTHIA, the *creeper*, in natural history, a genus of birds of the order Picæ. Generic character: bill sharp-pointed, slender, and incurvated; nostrils small; tongue varying in shape; legs somewhat stout; toes three before and one behind, the latter large; claws long and hooked; tail of twelve feathers.

These birds are distinguished from humming birds, with which they have sometimes been confounded, by the circumstances of their being to be met with in

every quarter of the world; by their bill universally terminating in a point, and by their feeding in a great degree, though not exclusively, on insects. There are no less than forty-nine species, of which the principal are,

C. familiaris, the tree-creeper of Albinus. This bird is scarcely larger than the crested wren, and is to be observed in various parts of Europe, but especially in England. It runs on the bark of a tree with extreme ease and rapidity, and the instant it perceives a human being near it, conceals itself on the opposite side of the trunk or branch, repeating this movement according to the corresponding movement of the person whose notice it wishes to avoid, and thus perpetually endeavouring, and almost in all cases with success, to evade the observation of its pursuer. It feeds almost solely on insects, which it finds in the hollows, and among the moss, of trees.

C. Lotenia, or Loten's creeper, is a native of Ceylon and Madagascar. It builds its nest of the down of plants, and is subjected to the hostility of a spider, in those countries, nearly as large as itself, which pursues it with extreme ardour, and delights in sucking the blood of its young.

C. cœrulea, or blue creeper, is an inhabitant of Cayenne, and is remarkable for the ingenuity it exhibits in the construction of its nest, by which it precludes any attack from the monkeys and snakes, as well as lizards, which abound in that country. This nest is suspended from some slender twig at the end of a branch, to which those animals dare not venture, as it would be too weak to support them. The entrance to the nest is towards the ground, and about a foot distant from the body of it, to which the bird climbs through a narrow neck of this extraordinary length.

C. sannio, or mocking creeper, is found in New Zealand, has an agreeable note, and can so modulate its voice, as seemingly to imitate the notes of all birds: hence it is called the mocking creeper. See Plate IV. Aves, fig. 3.

CERTIFICATE, in law, a writing made in any court, to give notice to another court of any thing done therein. The clerks of the crown, assize, and the peace, are to make certificates into the King's Bench of the tenor of all indictments, convictions, outlawries, &c.

CERTIORARI, a writ which issues out of the chancery, directed to an inferior court, to call up the records of a cause there depending, in order that justice may be done. And this writ is obtained upon complaint, that the party who seeks it has received hard usage, or is not like to have an impartial trial in the inferior court. A certiorari is made returnable either in the King's Bench, Common Pleas, or in Chancery.

It is not only issued out of the Court of Chancery, but likewise out of the King's Bench, in which last-mentioned court it lies where the King would be certified for a record. Indictments from inferior courts, and proceedings of the quarter sessions of the peace, may also be removed into the King's Bench by a certiorari; and here the very record must be returned, and not a transcript of it; though usually in Chancery, if a certiorari be returnable there, it removes only a tenor of the record.

CERVICAL *nerves*, in anatomy, are eight pair of nerves, so called as having their origin in the neck.

CERUMEN, is a viscid yellow-coloured liquid secreted by the glands of the auditory canal, which gradually becomes concrete by exposure to the air. It has an orange-yellow colour and a bitter taste. When slightly heated upon paper, it melts, and stains the paper like an oil; at the same time it emits a slightly aromatic odour. On burning coals it softens, emits a white smoke, which resembles that given out by burning fat; it afterwards melts, swells, becomes dark-coloured, and emits an ammoniacal and empyreumatic odour. A light coal remains behind. When agitated in water, cerumen forms a kind of emulsion, which soon putrefies, depositing at the same time white flakes. Alcohol, when assisted by heat, dissolves $\frac{5}{8}$ of the cerumen; the $\frac{3}{8}$ which remain behind have the properties of albumen, mixed however with a little oily matter.

Ether also dissolves this oily body; but it is much less bitter and much lighter coloured. When the albuminous part of cerumen is burnt, it leaves traces of soda and of phosphate of lime. From these facts Vauquelin considers cerumen as composed of the following substances:

1. Albumen
2. An inspissated oil
3. A colouring matter
4. Soda
5. Phosphate of lime.

CERUSSE, or *white lead*, a substance

compounded of the acetic acid and lead. It is formed by the metal plates of lead being exposed to the vapours arising from boiling vinegar, and the metal being oxydized by the action of the air, aided by the affinity of the acid. This has been regarded either as an oxide or a sub-carbonate of lead; though it appears probable that it should contain some acetic acid. It serves as the basis from which the more perfect salt, the sugar of lead of commerce, is formed: the cerusse, in fine powder, is boiled in distilled vinegar, the vinegar being poured off as it loses its acidity, and fresh qualities being successively added. The liquors thus procured are then evaporated nearly to the consistence of honey; and, on cooling, masses are formed, consisting of a congeries of needle-like prisms. From the account given by Pontier of the manufacture of this salt, it appears, that it is also formed by exposing plates of lead to the action of distilled vinegar and of the atmospheric air: the plates, as they are incrusted with oxide at the surface of the vinegar, are plunged to the bottom, until this oxide is dissolved, and are again raised to the surface. The acid is thus at length saturated, and, by evaporation, the solution is brought to crystallize.

CERVUS, the *deer*, in natural history, a genus of Mammalia of the order Pecora. The generic character; horns solid, and while the animal is young, covered with a hairy skin, growing from the top, annual, branched, and naked; eight front teeth in the lower jaw; no canine teeth. There are twelve species, of which we shall particularly notice the C. Aces, or the elk. This animal sometimes attains the height of seventeen hands, and the weight of twelve hundred and thirty pounds; but such cases are somewhat extraordinary. It is larger in Asia and America than in Europe. It abounds in the cold countries of Sweden, Siberia, and Canada, and in the last is called also the moose deer. Its principal food is derived from the boughs of the forest trees in these desolate regions, and the night is generally preferred for its repasts. Its manners are extremely gentle and inoffensive; it will, however, defend itself with great courage and dexterity, both with its horns and fore feet, and has been known, with a single blow from the latter, to destroy a wolf. Among the North American Indians the hunting of the elk is an employment of considerable interest and preparation. One party is occupied in surrounding a large tract of country near the lakes or rivers, and, by means of their dogs, in rousing the elks contained in it, (who, finding all escape from danger impracticable by land, press onwards to the water. Here, however, they are received by another party of enemies, whose canoes, extending in a crescent form, inclose a considerable space, and reach from shore to shore, and who destroy their victims by clubs and lances. They are often taken also by snares, into which they are driven by the noises and alarms of the Indians, and in which they are inextricably entangled amidst slips of raw hides, or confined within so small a compass, that they become sure marks for the arrows of their adversaries. It is remarked of the elk, that when first dislodged, he drops on the ground for a few seconds, as if labouring under a complete prostration of strength, occasioned, probably, by the influence of fear. This is the moment invaluable to the hunter, who, if he miss this opportunity, frequently fails in every other, as the animal, after a very short pause, is roused to the most vigorous flight, which he continues without suspension, for a progress of twenty or thirty miles.

In the bogs of Ireland, as well as in America, horns have been repeatedly dug up of an enormous size, which apparently belonged to an animal of the deer kind, but are far superior in dimensions to those of any animal now known by naturalists. Their length has sometimes been of eight feet, and the distance from the tip of one to that of another has extended to fourteen feet. These are justly considered as most curious specimens in the collections of natural productions, and the idea of their annual reproduction is well calculated to excite astonishment. Mammalia, Plate VIII. fig. 1.

C. tarandus, or the rein deer. When full grown, this animal is about the height of four feet six inches, and both sexes are furnished with horns, those of the male, however, being much larger than the females. It is found, more abundantly than any where else, in Lapland and Norway. It is met with in the north of Asia, so far as Kamschatka, and in America so far south at Canada. With the Laplander the rein deer is a complete substitute for the horse, the cow, the sheep, and the goat. He possesses two breeds of this animal, the wild and the tame. The former of these are by far the most vigorous, but are also often

extremely obstinate, and not a little ferocious, turning upon their drivers with dangerous, and sometimes fatal, fury. The tame rein deer, therefore, is almost universally preferred. It is trained when young to draw the sledge, which is the common vehicle of the country, which is made extremely light, and covered with the skin of a young deer. The deer is fastened to this carriage by a strap, which passes round his neck, and comes down between his legs, and is guided by a cord, tied round his horns, and held by the driver, whose cheering voice is perpetually exerted to encourage the animal on his progress, and who is furnished also with a goad for occasional applications. One of these deer has been known several times to draw its sledge and owner a journey of 50 miles, without stopping; an exertion, however, which is almost uniformly fatal to it. To a progress of thirty miles without halting it is competent, without any injury. The constant mode of travelling in Lapland in winter is by means of the deer and sledge. It is extremely speedy, yet at the same time inconvenient and dangerous, and can be accomplished only when the snow is frozen and glazed. The favourite food of this animal is a species of moss, which, in Lapland, covers the face of the country through large tracts, and to obtain which, in winter, the horns of the rein deer enable it to dig through the snow with great facility. The attention paid by the Laplander to these animals constitutes his principal occupation. In the rigour of winters they are sheltered and nursed by him; in the short summers they are led to the banks of the lakes and rivers, or to the tops of the mountains, where they may brouse on their favourite lichen; which from the fullness and sweetness of the pasture, supplies al lthe richness and variety of his temperate banquets, fig. 2.

C. elaphus, or the stag. This animal is found in nearly all the temperate climates of Europe and Asia. It is also found in North America, but attains its largest size in Siberia. From the branchiness of its horns, the elegance of its form and movements, and the strength of its limbs, it deservedly attracts particular admiration, and may be regarded as a principal embellishment of the forest. The stag is remarkable for a fine eye and an acute sense of smelling. Its ear, also, is exquisitely sensible, and musical sounds appear to possess over him the power of exciting complacency, if not rapture. His enemies not unfrequently employ the shepherd's pipe to decoy him to his destruction; and Mr. Playford, in his "Introduction to Music," states, that he once met a herd of twenty stags near Royston, which readily followed the tones of a violin and bagpipe, played by their conductors, but stopped whenever the music was suspended. Their whole progress from Yorkshire to Hampton-court was attended, and it was supposed extremely facilitated, by these sounds. The stag is simple and unsuspicious, and employs no arts to avoid detection or pursuit, until after having received considerable molestation. His food consists, in winter, of moss and bark; in spring of the catkins of willow and hazel, and the flowers and buds of cornel; in summer, of the grain of rye and the tender shoots of the alder; in autumn, of the leaves of brambles, and the flowers of heath and broom. He eats with slowness, and ruminates with some considerable effort, in consequence of the distance between the first stomach and the mouth. In March, generally, he sheds his horns, which are not completely renewed till August. It will live to between thirty and forty years of age, and was, formerly, amidst the other vulgar errors of antiquity, supposed capable of attaining most extraordinary duration. The stag is supposed to have been introduced from France into England, where it has latterly been made to give way to the fallow deer, an animal more gentle in its manners, and more valuable as food. In some parts of Scotland the stag is yet to be found in its original wild state.

C. dama, or the fallow deer. This animal is, in general, much smaller than the stag; but in Spain is nearly equally large: in France and Germany, it is rarely to be found, and it has never been known to have existed in America: it has the elegance of the stag, connected with a much more tractable disposition: it sheds its horns, which, as in the stag species, are peculiar to the male, every year; is stated to live to the age twenty years, and arrives at its maturity in three: it is by no means fastidious in its food. Fig. 4.

C. capreolus, or the roe. This is the smallest of the animals of this class in Europe, and generally of a reddish-brown colour: it is graceful, sprightly, and courageous, particularly cleanly, and delighting in dry and mountainous situations: it leaves a strong scent behind it, but possesses such arts of defence, that by various doublings, and intermixtures of past with present ema-

nations from its body, it frequently baffles the most experienced dogs, and remains in a state of security while the full pack passes almost close by its retreat, distinguishing it neither by sight nor smell: it differs from the stag in the constancy of its attachments, and the parents and their young constitute a family, never associating with strangers: two fawns are generally produced by the female at a birth, one of each sex, which, living together, form a mutual and invincible attachment. When a new family is to be nursed, the former is driven off to provide for itself, but returns again after a certain interval to the mother, whose former affection is restored: a final separation speedily takes place, however, soon after this return, between the fawns of the season preceding the last and their dam, and the former remove to a distance, constituting a distinct establishment, and rearing an offspring of their own. When the female is about to bring forth, she secludes herself in some remote recess of the forest, from which she returns at the end of about ten days, with her fawns, just able slowly and weakly to follow her steps: in cases of danger she hides them in a place deemed by her most secure from the enemy, and attracts the attention of the latter from them to herself; happy, by her own perils or even destruction, to effect the security of her offspring. In winter these animals feed on brambles, broom, heath, and catkins; and in spring they eat the young wood and leaves of almost every species of trees, and are said to be so affected, as it were with intoxication, by the fermentation of this food in their stomachs, that they will approach men and other enemies, whom they generally shun with extreme care, without apprehension or suspicion. The flesh of these animals is excellent, though after two years of age that of the males is ill-flavoured and tough. Some roes have been found perfectly white, and in the forest of Lucia, in the duchy of Lunenburgh, a race of jet black roes is to be met with, in every other respect but this marked peculiarity of colour, (which is also stated to be an invariable distinction) resembling the common roe.

Roes may be tamed to a certain degree, but never so as to be completely familiarized. The share of natural wildness which they ever retain is connected, especially in males, with much caprice, and even antipathy to particular individuals, whom they will assault with their horns, and afterwards violently trample on with their feet. The roe exists now in no part of Ireland, and, in Great Britain, only in a few districts of the Highlands.

C. axis, or spotted axis, is a most beautiful animal, marked with numerous spots: it is described by Pliny, and is said to have been sacred to Bacchus among the ancients. Fig. 3.

CESARE, among logicians, one of the modes of the second figure of syllogisms; the minor proposition of which is an universal affirmative, and the other two universal negatives: thus,

CE No immoral books ought to be read:
SA But every obscene book is immoral:
RE Therefore no obscene book ought to be read.

CERTIFICATION *of assize of novel disseisin*, a writ granted for the re-examination or review of a matter passed by assize before any justices; as where a man appearing by his bailiff to an assize brought by another, hath lost the day, and having something more to plead for himself, as a deed of release, &c. which the bailiff did not or might not plead for him; desires a farther examination of the cause, either before the same justices or others, and obtaineth letters patent to that effect.

CERTIORARI, *writ of*, is an original writ, issuing out of the Court of Chancery or the King's Bench, directed in the King's name, to the judges or officers of inferior courts, commanding them to certify or to return the records of a cause depending before them, to the end that the party may have the more sure and speedy justice, before the King or such justices as he shall assign to determine the cause.

A certiorari lies in all judicial proceedings in which a writ of error does not lie; and it is a consequence of all inferior jurisdictions erected by act of parliament, to have their proceedings returnable in the King's Bench.

In particular cases, the court will use their discretion to grant a certiorari, as, if the defendant be of good character, or if the prosecution be malicious, or attended with oppressive circumstances.

The Courts of Chancery and King's Bench may award a certiorari to remove the proceeding from any inferior courts, whether they be of ancient or newly created jurisdiction, unless the statute or charter which creates them exempts them from such jurisdiction.

CESSION, in law, an act by which a

person surrenders and transmits to another person, a right which belonged to himself. Cession is more particularly used in the civil law for a voluntary surrender of a person's effects to his creditors, to avoid imprisonment.

Cession, in the ecclesiastical law, is when an ecclesiastical person is created a bishop, or when a parson of a parish takes another benefice without dispensation, or being otherwise qualified. In both these cases their first benefices become void by cession, without any resignation; and to those livings that the person had, who was created bishop, the King may present for that time, whosoever is patron of them; and in the other case the patron may present; but by dispensation of retainder, a bishop may retain some or all the preferments he was entitled to, before he was made bishop.

CESTRUM, in botany, *English bastard jasmine*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel-form; stamens emitting a toothlet from their middle; berry unilocular. There are nine species, of which C. nocturnum, night smelling cestrum, is about seven feet high, covered with a greyish bark, and divides upward into many slender branches, which generally incline to one side; they are garnished with leaves placed alternately, nearly four inches long, and one and a half broad; the flowers are produced at the wings of the leaves, in small clusters, standing upon short peduncles, each sustaining four or five flowers, of an herbaceous colour. They appear in August, but are not succeeded by berries in this country: those which come from America are small, and are of a dark brown colour. It is a native of the island of Cuba.

CESTUI, a French word, signifying he or him, frequently used in our law-writings. Thus "cestui qui trust," a person who has lands, &c. committed to him for the benefit of another; and if such person does not perform his trust, he is compellable to it in Chancery. "Cestui qui vie," one for whose life any lands, &c. are granted. "Cestui qui use," a person to whose use any one is infeoffed of lands or tenements. Formerly the feoffees to uses were deemed owners of the land, but now the possession is adjudged in cestui qui use.

CETE, in natural history, the seventh order of Mammalia, in the Linnæan system of animals, including the four genera, Monodon, or narval; Balæna, whale; Physeter, cachalot; and Delphinus, dolphin. The cetaceous tribe has one or more spiracles placed on the fore part of the skull; no feet; pectoral fins without nails, and tail horizontal. The cetaceous order of animals has nothing peculiar to fish, except living in the same element, and being endowed with the same powers of progressive motion as those fishes which are intended to move with considerable velocity. The popular idea of cetaceous animals being fishes is so strongly impressed on the public mind, that it can never, perhaps, be entirely removed, for the critical observations of naturalists appear too abstruse to be generally examined, and of consequence to be commonly understood. The cetaceous tribes live in the same element as fishes, and, partaking somewhat of their external figure, will ever be considered as appertaining to that class of animals by the less informed portion of mankind.

Cetaceous animals, or, as Dr. Shaw expresses them, "fish-formed mammalia," have lungs, intestines, and other internal organs, formed on the same principle as in quadrupeds; and, indeed, on strict comparison, the principal differences that exist between them will not be found very considerable; one of the most material seems to consist in their want of posterior legs, the peculiar structure of the tail supplying that defect, this being extremely strong and tendinous, and divided into two horizontal lobes, but which has no internal bones. Like quadrupeds, they have a heart furnished with two auricles, and two ventricles, and their blood is warm and red: they breathe by their lungs, and not by means of gills, as in true fishes. In their amours they agree with quadrupeds; the female produces her young alive, which rarely happens among fishes, and she suckles them with her teats, as in the true mammalia. The structure of their brain, their sexual organs, stomach, and liver, resemble those of mammiferous animals. Their skin is smooth, or not covered with scales; and their tail is placed in a position the very reverse of fishes, in being always flat and horizontal, instead of vertical. The cetaceous animals, the cachalot and dolphin genera, have the mouth armed with conic teeth; the whales with horny laminæ in the upper jaw; and the narval with teeth, or tusks of enormous length. They are neither sanguinary nor ferocious. Their stomachs are large, and divided into chambers to the

number of five, as in the whale and porpoise, or even seven, as in the narval. In the last particular they seem to constitute an intermediate link between carnivorous and herbivorous animals, approaching nearly to ruminating quadrupeds; but differ in subsisting on animal food, as they live chiefly on actiniæ, medusæ, and other zoophytes, on crustaceous animals, and on small fish. See MONODON, BALÆNA, PHYSETER, and DELPHINUS.

CEYLANITE, in mineralogy, a species of the flint genus, of a dark indigo-blue, which passes into a bluish or greenish black. It occurs sometimes in rolled pieces, and angular pieces, and sometimes also crystallized. Specific gravity 3.76 to 3.79. It is found, in sand, with tourmalin and other fossils.

CHÆROPHYLLUM, in botany a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: invol. reflected, concave; petals heart-inflected; fruit oblong, even. There are ten species, of which C. bulbosum, tuberous chervil, is about five or six feet high with reddish spots, smooth and even at top, swelling at the joints. Both umbels of unequal rays, the partial rather convex; petals white, obcordate, unequal; some florets of the disk abortive. It is a native of Germany, Austria, Switzerland, and Norway; in hedges and by wood sides; flowering in June and July. C. silvestre, wild cicely or cow-weed, and C. temulum, wild chervil, rough cow-parsley, are both common weeds; the others are admitted only into botanic gardens, not being in use either for medicine or in the kitchen.

CHÆTODON, in natural history, a genus of fishes of the order Thoracici: generic character: head and mouth small; teeth close set, flexile, setaceous; gill membrane three, four, five, or six rayed; body broad, compressed, and generally fasciated; dorsal and anal fin thick, fleshy, and scaly at the base. The fishes of this numerous genus are generally extremely beautiful, their colours remarkably vivid, and their variegations consisting chiefly of stripes, lines, bends, or spots; their body covered with strong scales, which are finely denticulated at the margin; the dorsal and anal fins are remarkably broad. According to Gmelin there are about 60 species. Dr. Shaw has enumerated and described still more. The latter has divided them into classes, of which the first is described as having a single dorsal fin; and even or rounded tail, or very slightly inclining to crescent-shaped in some few species; among the species of this class is C. plectorhenchus, or pleat-nose chætodon. See Plate III. Pisces, fig. 1. The species of the second class have a single dorsal fin, and forked or lunated tail; those of the third class have two dorsal fins.

CHAFF, in agriculture, the husky substance of corn, which is separated by threshing and winnowing. It also sometimes signifies the rind of corn; thus, barley that has a thick rind is said to be thick-chaffed; and it likewise implies straw, &c. cut small for the purpose of being given to horses and other cattle, mixed with corn. This substance, whether obtained by the dressing of grain or made from straw and other matters by cutting, is highly useful in the feeding of horses and many other animals, as saving much other more valuable food. Besides its advantage in the common feeding of animals, it is of vast utility in the fattening of different sorts of animals, where much luxuriant green food is given, as a dry meat; as without some sort of material of this nature they never go on well.

CHAIN, a long piece of metal composed of several links or rings, engaged the one in the other. They are made of divers metals, some round, some flat, others square, some single, some double. A gold chain is one of the badges of the dignity of the Lord Mayor of London, and remains to the person after his being divested of that office, as a mark that he has passed the chair. It is also the badge of office of the sheriff, but only while in office.

CHAIN is also a string of gold, silver, or steel-wire, wrought like a tissue, which serves to hang watches, tweezer-cases, and other valuable toys upon. The invention of these pieces of workmanship was derived originally from England, whence foreigners give them the name of chains of England.

In making these chains, a part of the wire is folded into little links of an oval form, the longest diameter about three lines, the shortest one. These, after they have been exactly soldered, are again folded into two, and then bound together and interwoven by means of several other little threads of the same thickness, some of which passing from one end to the other, imitate the warp of a stuff, and the others, which pass transversely the woof; there are at least four thousand little links in a

chain of four pendants, so equally, and at the same time so firmly connected, that the eye takes the whole to consist of one piece.

CHAIN, in surveying, a measure of length, made of a certain number of links of iron-wire, serving to take the distance between two or more places. Gunter's chain is of 100 such links, each measuring $7\frac{92}{100}$ inches, and consequently equal to 66 feet, or four poles. When you are to measure any line by this chain, you need have regard to no other denomination than chains and links, which are to be set down with a full point between them. Thus, for instance, if the side of a close is found to be 10 chains 14 links, it must be set down thus, 10.14. But if the links be under 10, a cypher must be prefixed; thus 10 chains 7 links, must be set down 10.07.

Then if the field be a square or parallelogram, if you multiply the length expressed in chains and links, by the breadth expressed in the same manner, and cut off five figures from the product, those towards the left hand will be acres; then multiply the separated figures by four, cutting off the same number of figures, and you will have the roods or quarters of an acre; and lastly multiply the remaining figures by 40, cutting off five as before, and you will have the square perches. See SURVEYING.

CHAINS, in a ship, those irons to which the shrouds of the masts are made fast to the chain walls.

CHAIN *walls*, in a ship, the broad timbers which are made jetting out of her sides, to which the shrouds are fastened and spread out, the better to secure the masts.

CHAIN *shot*, two bullets with a chain between them. They are used at sea to shoot down yards or masts, and to cut the shrouds or rigging of a ship.

CHAIN *pump*. See PUMP.

CHALCEDONY, in mineralogy, a species of the flint genus: of which there are, according to Werner, two subspecies, *viz.* the common chalcedony and the carnelian: the colour of the former is grey in all its shades. It is commonly semi-transparent, harder than flint, brittle, difficultly frangible; and the specific gravity, according to Kirwan, is about 2.6. Infusible before the blow-pipe. It is found mostly in balls, in amygdaloid, also in angular pieces and veins, in porphyry and amygdaloid. The cubic variety occurs in Transylvania, and the other varieties in Iceland, the Feroe islands, Silesia, Saxony, Siberia, Cornwall, Scotland, &c. It is susceptible of a fine polish, and is employed as an article of jewelry. It derives its name from Chalcedon, in Asia, where it was first found. Onyx is considered as the most valuable variety of this species, and on account of its being capable of receiving a high polish is very much prized. It is principally cut in bas relief work, and the finest specimens for that purpose are brought from the East Indies. The dendritic variety is named mocha stone, being brought, originally, as was supposed, from Mocha on the Red Sea; but it is now generally understood that the word mocha is a corruption from the German word mocks, which signifies moss; and it is affirmed that no stone of the kind is found near Mocha.

The principal colour of the carnelian is blood red, of all degrees of intensity; from this it passes into milk-white, and also into a kind of yellow. Semi-transparent; and in many other of its characters it agrees with the common chalcedony. It is found accompanying agate, and, in general, has the same geognostic situation as chaledony. The fine oriental varieties occur in rolled pieces. The most beautiful carnelian is brought from Arabia and Hindostan; it is also found in different parts of Europe, and is used for seals, bracelets, crosses, and other ornaments.

CHALCIS, in natural history, a genus of insects of the order Hymenoptera: mouth with a horny compressed jaw; feelers four equal; antennæ short, cylindrical, fusiform; the first joint a little thicker; thorax gibbous, lengthened behind in the place of a scutel; abdomen rounded and slightly petiolate. There are eleven species.

CHALDRON, a dry English measure, consisting of thirty-six bushels, heaped up according to the sealed bushel kept at Guildhall, London: but on ship-board, twenty-one chaldron of coals are allowed to the score.

CHALK, in natural history, a species of CALK, which see.

Chalk, where it is found at all, is the preponderating substance, and may therefore be considered as characterizing a peculiar species of mineral formation. It is perhaps the most recent of all the varieties of calcareous carbonates; it occurs in strata for the most part nearly horizontal, alternating with thin layers of flint nodules, and with the same irregularly dispersed through its substance: it contains in abundance the relics of marine organized bodies, such as echinites, glossopetræ pectinites, &c. and also not unfrequently the hard parts of

amphibious and land animals, as the heads and vertebræ of crocodiles, and teeth of elephants. Chalk hills never rise to a higher elevation than three or four hundred feet, and are at once distinguishable by the smooth regularity of their outline, and their remarkable tendency to form cup-shaped concavities. Ridges of chalk, in England at least, are always bordered by parallel ranges of sand or sandstone, beneath and alternating with which are situated the beds of fullers-earth. Chalk hills are also singularly characterized by their dryness and their verdure: the most porous sandstone is scarcely so deficient in springs of water, and yet except upon almost perpendicular descents, the white surface of the chalk is uniformly covered with fine turf or wood.

The chalk hills in England occupy a greater extent than in any other country, they run in a direction nearly from east to west parallel to each other, and separated by ranges of sand-stone, and low tracts of gravel and clay. The most northern and loftiest range of chalk commences at the promontory of Flamborough-head, in Yorkshire, and proceeds westward for nearly 20 miles. In the county of Lincoln are some fragments of a ridge near Grantham. Two ridges traverse the midland counties, and reach as far west as the borders of Oxfordshire: these ridges are no where so conspicuous as in the county of Bedford, where they approach near to each other, being only separated by the Woburn and Ampthill range of sand-stone. The country south of the Thames also contains two ridges, the one commencing at the North and South Foreland, passing through the north of Kent, the middle of Surry, and the north of Hampshire, and including the North Downs of Banstead, Epsom, &c.: the other, commencing near Hastings and at the lofty promontory of Beachy-head, passes through Sussex and the south of Hampshire, into Dorsetshire, including the South Downs. The north part of France also abounds in chalk: it is besides met with in some of the Danish islands in the Baltic, and in Poland.

The uses of chalk are very extensive: the more compact kinds are used as building stone, and are burnt to lime (nearly all the buildings in London being cemented with chalk-mortar): it is also largely employed in the polishing of metals and glass, in constructing moulds to cast metal in, by carpenters and others as a material to mark with, and by starch-makers and chemists to dry precipitates on, for which it is peculiarly qualified on account of the remarkable facility with which it absorbs water.

CHALK *stones.* It is well known that concretions occasionally make their appearance in joints long subject to gout. These concretions, from their colour and softness, have received the name of chalk-stones. They are usually small, though they have been observed of the size of an egg. It had long been the opinion of physicians that these concretions were similar to the urinary calculi. See CALCULI.

Of course, after the discovery of uric acid by Scheele, it was usual to consider the gouty chalk-stones as collections of that acid. They were subjected to a chemical analysis by Dr. Wollaston in 1797, who found them compo ed of uric acid and soda. Gouty concretions are soft and friable. Cold water has little effect upon them; but boiling water dissolves a small portion. If an acid be added to this solution, small crystals of uric acid are deposited on the sides of the vessel. These concretions are completely soluble in potash when the action of the alkaline solution is assisted by heat. When treated with diluted sulphuric or with muriatic acid, the soda is separated; but the uric acid remains, and may be separated by filtration. The liquid, when evaporated, yields crystals of sulphate or muriate of soda, according to the acid employed. The residuum possesses all the characters of uric acid.

When uric acid, soda, and a little warm water, are triturated together, a mass is formed, which, after the surplus of soda is washed off, possesses the chemical properties of gouty concretions.

CHALLENGE, in law, is an exception made to jurors, who are returned to a person on a trial.

This challenge is made either to the array, or to the polls: to the array, when exception is taken to the whole number of jurors impannelled; and to the polls, when an exception is made to one or more of the jury as not indifferent.

Challenge to the jurors is likewise divided into challenge principal or peremptory, and challenge for cause; that is, upon cause or reason alleged. Challenge principal, is what the law allows without any cause alleged, or further examination: as a prisoner arraigned at the bar for felony may challenge peremptorily the number allowed him by law, being twenty, one after an

other, alleging no further cause than his own dislike: and the jurors, so challenged, shall be put off, and new ones taken in their places.

In cases of treason the number of thirty-five jurors may be peremptorily challenged, without shewing any cause; and more, both in treason and felony, may be challenged, shewing cause.

If those who prosecute for the king challenge a juror, they are to assign the cause; and if the cause alleged be not a good one, the inquest shall be taken. When the king is party, if the other side challenge any juror above the number allowed, he ought to shew cause of his challenge immediately, while the jury is full, and before they are sworn. This was supposed to be law with regard to challenges made for the crown, but in the memorable state trials of 1794, the crown lawyers challenged without shewing cause, declaring that they were not bound to shew reason till the whole pannel was gone through, and then, only in case that a sufficient number of jurors were not left. This was the case, and the consequence was, that the persons whom they had challenged were then taken, against whom it was ascertained there was no cause of challenge whatever. Challenge to the array is in respect of the partiality or default of the sheriff, coroner, or other officer that made the return; and it is then twofold. First, principal challenge to the array, which if it be made good, is a sufficient cause of exception, without leaving any thing to the judgment of the triers, as if the sheriff be of kindred to either party, or if any of the jurors be returned at the nomination of either of the parties. Secondly, challenge to the array for favour, which being no principal challenge, must be left to the discretion and conscience of the triers. As where either of the parties suspect that the juror is inclined to favour of the opposite part. Principal challenge to the polls, is where cause is shewn, which if found true, stands sufficient of itself, without leaving any thing to the triers; as if the juror be under the age of 21, it is a true cause of challenge.

CHALYBEATE. See Mineral Waters.

CHAMA, in natural history, a genus of Vermes Testacea. Animal a tethys: shell bivalve, rather coarse; hinge with a callous gibbosity, obliquely inserted in an oblique hollow; anterior slope closed: about 25 species, of which we shall notice only the C. gigas: shell plaited, with arched scales; posterior slope gaping, with crenulate margins. It inhabits the Indian ocean, and is sometimes so small as not to measure an inch in length; sometimes far exceeds all other testaceous productions, having been found of the weight of 532 pounds, and the fish or inhabitant so large as to furnish 120 men with food, and strong enough to cut asunder a cable, and lop off men's hands; shell lucid, white, sometimes rosy, varied with yellow, red, and white; posterior aperture ovate, with a tumid crenate circumference; margin toothed; hinge armed with a tooth besides the callus.

CHAMÆLEON, in botany, a genus of the Syngenesia Segregata class and order. Calyx six or eight flowered, imbricate, many-leaved; calycle one-flowered, many-leaved; florets tubular, all hermaphrodite; receptacle naked; seeds covered with a calycle growing to them; one species, a native of the South of Europe.

CHAMÆROPS, in botany, *dwarf palm*, or *palmetto*. Essential character: hermaphrodite; calyx three-parted; corolla three-petalled; stamina six; pistils three; drupes three, one-seeded: males; dioecous, as in the hermaphrodite. There are three species, of which C. humilis, dwarf fan palm, never rises with an upright stem; the foot stalks of the leaves rise immediately from the head of the root, and are armed on each side with strong spines; they are flat on their upper surface, and convex on their under side: from between the leaves comes out the spadix or club, which sustains the flowers; this is covered with a thin spathe or hood, which falls off when the bunches open and divide. It grows naturally in Italy, Sicily, and Spain, particularly in Andalusia, where, in the sandy land, the roots spread and propagate so fast, as to cover the ground in the same manner as fern in England.

CHAMBERLAIN, an officer charged with the management and direction of a chamber.

There are almost as many kinds of chamberlains as chambers, the principal of which are as follow:

Chamberlain, *Lord, of Great Britain*, the sixth great officer of the crown; to whom belongs livery and lodging in the king's court; and there are certain fees due to him from each archbishop or bishop, when they perform their homage to the king; and from all peers at their creation, on doing their homage. At the coronation of every king, he is to have forty ells of

crimson velvet for his own robes. This officer, on the coronation-day, is to bring the king his shirt, coif, and wearing clothes; and after the king is dressed, he claims his bed, and all the furniture of his chamber for his fees: he also carries at the coronation, the coif, gloves, and linen to be used by the king on that occasion; also the sword and scabbard, the gold to be offered by the king, and the robes royal and crown: he dresses and undresses the king on that day, waits on him before and after dinner, &c. To this officer belongs the care of providing all things in the House of Lords, in the time of the Parliament: to him also belongs the government of the palace of Westminster: he disposes likewise of the sword of state, to be carried before the king, to what lord he pleases.

The office of Lord Great Chamberlain of England is hereditary; and where a person dies seized in fee of this office, leaving two sisters, the office belongs to both, and they may execute it by deputy, but such deputy must be approved of by the king, and must not be of a degree inferior to a knight. To the Lord Chamberlain the keys of Westminster Hall, and the Court of Requests, are delivered upon all solemn occasions. He goes on the right hand of the sword next the king's person. The Gentleman Usher of the Black Rod, Yeoman Usher, &c. are under his authority.

Chamberlain, *Lord, of the Household*, an officer who has the oversight and direction of all the officers belonging to the king's chambers, except the precinct of the king's bed-chamber.

He has the oversight of the officers of the wardrobe at all his Majesty's houses, and of the removing wardrobes, or of beds, tents, revels, music, comedians, hunting, messengers, &c. retained in the king's service. He moreover has the oversight and direction of the serjeants at arms, of all physicians, apothecaries, surgeons, barbers, the king's chaplains, &c. and administers the oath to all officers above stairs.

Chamberlain *of London* keeps the city money, which is laid up in the chamber of London: he also presides over the affairs of masters and apprentices, and makes free of the city, &c. His office lasts only a year, but the custom usually obtains to rechoose the same person, unless charged with any misdemeanor in his office.

CHAMBERS (Ephraim), author of the dictionary of sciences called the "Cyclopædia". He was born at Milton in the county of Westmoreland, where he received the common education for qualifying a youth for trade and commerce. When he became of a proper age, he was put apprentice to Mr. Senex, the globe-maker, a business which is connected with literature, especially with geography and astronomy. It was during Mr. Chambers's residence with this skilful artist, that he acquired that taste for literature which accompanied him through life, and directed all his pursuits. It was even at this time that he formed the design of his grand work, the Cyclopædia; some of the first articles of which were written behind the counter. To have leisure to pursue this work, he quitted Mr. Senex, and took chambers at Gray's Inn, where he chiefly resided during the rest of his life. The first edition of the Cyclopædia, which was the result of many years intense application, appeared in 1728, in 2 vols. folio. The reputation that Mr. Chambers acquired by the execution of this work, procured him the honour of being elected F. R. S. Nov. 6, 1729. In less than ten years time, a second edition became necessary; which accordingly was printed, with corrections and additions, in 1738; and this was followed by a third edition the very next year.

Mr. Chambers's close and unremitting attention to his studies at length impaired his health, and obliged him occasionally to take a country lodging, but without much benefit; he afterwards visited the south of France, but still with little effect; he therefore returned to England, where he soon after died, at Islington, May 15, 1740, and was buried at Westminster Abbey.

After the author's death, two more editions of his Cyclopædia were published. The proprietors afterwards procured a supplement to be compiled, by Mr. Scott and Dr. Hill, but chiefly by the latter, which extended to two volumes more; and the whole has since been reduced into one alphabet in four volumes, by Dr. Rees, forming a very valuable body of the sciences.

A new edition of the same work, or rather a new work under the title of the "New Cyclopædia," is now publishing by the same learned Editor. This work, of which Dr. Rees has published already nine volumes, will probably extend to thirty volumes quarto. It will, when complete, be unquestionably the most comprehensive body of science ever presented to the world.

CHAMELEON. See Lacerta.

CHAMPION, a person who undertakes

a combat in the place or quarrel of another; and sometimes the word is used for him who fights in his own cause.

It appears that champions, in the just sense of the word, were persons who fought instead of those that, by custom, were obliged to accept the duel, but had a just excuse for dispensing with it, as being too old, infirm, or being ecclesiastics, and the like. Such causes as could not be decided by the course of common law, were often tried by single combat; and he who had the good fortune to conquer, was always reputed to have justice on his side. Champions who fought for interest only, were held infamous: these hired themselves to the nobility, to fight for them in case of need, and did homage for their pension.

When two champions were chosen to maintain a cause, it was always required that there should be a decree of the judge to authorize the combat: when the judge had pronounced sentence, the accused threw a gage or pledge, originally a glove or gantlet, which being taken up by the accuser, they were both taken into safe custody, till the day of battle appointed by the judge.

Before the champions took the field, their heads were shaved to a kind of crown or round, which was left at the top: then they made an oath that they believed the person who retained them to be in the right, &c. They always engaged on foot, and with no other weapon than a club and a shield, which weapons were blessed in the field by the priest, with a world of ceremonies; and they always made an offering to the church, that God might assist them in the battle.

The action began with railing, and giving each other ill language; and at the sound of a trumpet, they went to blows. After the number of blows or encounters expressed in the cartel, the judges of the combat threw a rod into the air, to advertise the champions that the combat was ended. If it lasted till night, or ended with equal advantage on both sides, the accused was reputed the victor. If the conquered champion fought in the cause of a woman, and it was a capital offence, the woman was burnt, and the champion hanged. If it was the champion of a man, and the crime capital, the vanquished was immediately disarmed, led out of the field, and hanged, together with the party whose cause he maintained. If the crime was not capital, he not only made satisfaction, but had his right hand cut off: the accused was close confined in prison, till the battle was over.

CHAMPION *of the king*, a person whose office it is, at the coronation of our kings, to ride armed into Westminister-hall, while the king is at dinner there, and, by the proclamation of a herald, make challenge to this effect, *viz.* "That if any man shall deny the king's title to the crown, he is there ready to defend it in single combat, &c." Which done, the king drinks to him, and sends him a gilt cup, with a cover, full of wine, which the champion drinks, and has the cup for his fee. This office is hereditary.

CHANCE, in a general sense, a term applied to events not necessarily produced, as the natural effects of any proper foreknown cause. We certainly mean no more in saying that a thing happened by chance, than that its cause is unknown to us: for chance itself is no natural agent or cause; it is incapable of producing any effect, and is no more than a creature of man's own making; for the things done in the corporeal world are really done by the parts of the universal matter, acting and suffering, according to the laws of motion establised by the author of nature.

Chance is also confounded with fate and destiny.

CHANCES, *doctrine of*, in mixed mathematics, a subject of great importance, especially as applied to the doctrine of life annuities, assurance, &c. in a great commercial country like this. The writers on this branch of science have been comparatively few. In our own language the principal treatises are a large quarto by De Moivre, and a very small work by the celebrated Mr. Thomas Simpson, in which, however, there are some problems never before attempted, or at least never before communicated to the public. In the year 1753, Mr. Dodson rendered this subject more accessible to persons not far advanced in analytical studies, by publishing in his second volume of the "Mathematical Repository" a number of questions, with their several solutions, with an express reference to the doctrine of life annuities. We shall give his first problem.

Suppose a round piece of metal, equally formed, having two opposite faces, one white the other black, be thrown up, in order to see which of those faces will be uppermost after the metal has fallen to the ground, when, if the white face appears uppermost, a person is to be entitled to 5*l.* it is

required to determine before the event what chance or probability that person has of receiving the 5*l.* and what sum he may expect should be paid to him in consideration of his resigning his chance to another.

Solution. Since there is nothing in the form of the metal that can incline it to shew one face rather than the other, and since it must shew one, it will follow, that there is an equal chance for the appearance of either face, or there is one chance out of two for the appearance of the white face, and consequently the probability of it may be expressed by the fraction $\frac{1}{2}$; if, therefore, any other person should be willing to purchase his chance, he must give for it the half of 5*l.* or 2*l.* 10*s.* This is one of the most simple cases: before, however, we proceed, it may be proper to give some definitions introductory to the doctrine.

Def. 1. The probability of an event is the ratio of the chance for its happening to all the chances for its happening or failing: thus, if out of six chances for its happening or failing there were only two chances for its happening, the probability in favour of such an event would be in the ratio of 2 to 6; that is, it would be a fourth proportional to 6, 2, and 1, or $\frac{1}{3}$. For the same reason, as there are four chances for its failing, the probability that the event will not happen, will be in the ratio of 4 to 6, or in other words, it will be a fourth proportional to 6, 4, and 1, or $\frac{2}{3}$. Hence, if the fractions expressing the probabilities of an event's both happening or failing be added together, they will always be found equal to unity. For let a be the number of chances for the event's happening, and b the number of chances for its failing, the probability in the first case being $\frac{a}{a+b}$, and in the second case $\frac{b}{a+b}$, their sum will be $= \frac{a+b}{a+b} = 1$. Having therefore determined the probability of any event's either happening or failing, the probability of the contrary will always be obtained by subtracting the fraction expressing such probability from unity.

Def. 2. The expectation of an event is the present value of any sum or thing which depends either on the happening or on the failing of such an event. Thus, if the receipt of one guinea were to depend on the throwing of any particular face on a die, the expectation of the person entitled to receive it would be worth 3*s.* 6*d.*; for since there are six faces on a die, and only one of them can be thrown to entitle the person to receive his money, the probability that such a face will be thrown being $\frac{1}{6}$ (according to Def. 1), it follows that the value of his interest before the trial is made, or, which is the same thing, that his expectation is equal to one-sixth of a guinea, or 3*s.* 6*d.* Were his receiving the money to depend on his throwing either of two faces, his expectation would be equal to two-sixths of a guinea, or 7*s.* And, in general, supposing the present value of the money or thing to be received to be A, the probability of the event's happening to be denoted by a, and of its failing by b, the expectation will be either expressed by $\frac{Aa}{a+b}$, or by $\frac{Ab}{a+b}$, according as it depends either on the event's happening, or on its failing.

Def. 3. Events are independent, when the happening of any one of them does neither increase nor lessen the probability of the rest. Thus, if a person undertook with a single die to throw an ace at two successive trials, it is obvious (however his expectation may be affected) that the probability of his throwing an ace in the one is neither increased nor lessened by the result of the other trial.

Theor. The probability that two subsequent events will both happen, is equal to the product of the probabilities of the happening of those events considered separately.

Suppose the chances for the happening and failing of the first event to be denoted by b, and those for its happening only to be denoted by a. Suppose, in like manner, the chances for the second event's happening and failing to be denoted by d, and those for its happening only by c; then will the probability of the happening of each of those events, separately considered, be (according to Def. 1) $\frac{a}{b}$ and $\frac{c}{d}$ respectively. Since it is necessary that the first event should happen before any thing can be determined in regard to the second, it is evident that the expectation on the latter must be lessened in proportion to the improbability of the former. Were it certain that the first event would happen, in other words, were $a = b$, or $\frac{a}{b} = 1$, the expectation on the second event would be $= \frac{c}{d}$. But if a is less than b, and the expectation on the second event is restrained to the contingency of its having happened the first time,

that expectation will be so much less than it was on the former supposition as $\frac{a}{b}$ is less than unity. Hence we have $1 : \frac{a}{b} :: \frac{c}{d} : \frac{ac}{bd}$ for the true expectation in this case.

Cor. By the same method of reasoning it will appear that the probability of the happening of any number of subsequent events is equal to the "product of the probabilities of those events separately considered," and therefore if a always denote the probability of its happening, and b the probability of its happening and failing, the fraction $\frac{a^n}{b^n}$ will express the probability of its happening n times successively, and (by Def. 1) the fraction $\frac{\overline{b-a}|^n}{b^n}$ will express the probability of its failing n times successively.

Rem. It should be observed that in some instances the probability of each subsequent event necessarily differs from that which preceded it, while in others it continues invariably the same through any number of trials. In the one case the probabilities are expressed, as in the theorem, by fractions, whose numerators and denominators continually vary; in the other they are expressed, as in the corollary, by one and the same invariable fraction. But this perhaps will be better understood by the following examples.

1. Suppose that out of a heap of counters, of which one part of them are white and the other red, a person were twice successively to take out one of them, and that it were required to determine the probability that these should be red counters. If the number of the white be 6, and the number of the red be 4, it is evident, from what has already been shown, that the probability of taking out a red one the first time will be $\frac{4}{10}$: but the probability of taking it out the 2nd time will be different; for since one counter has been taken out, there are now only nine remaining; and since, in order to the 2nd trial, it is necessary that the counter taken out should have been a red one, the number of those red ones must have been reduced to 3. Consequently, the chance of drawing out a red counter the 2nd time will be $\frac{3}{9}$, and the probability of drawing it out the 1st and 2nd time will (by this theorem) be $\frac{4 \times 3}{10 \times 9} = \frac{2}{15}$.

2. Suppose next, that with a single die, a person undertook to throw an ace twice successively: in this case the probability of throwing it the first, does not in the least alter his chance of throwing it the second time, as the number of faces on the die is the same on both trials. The probability, therefore, in each will be expressed by the same fraction, so that the probability, before any trial is made, will, by the preceding corollary, be $\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$. On these conclusions depend all the computations, however complicated and laborious, in the doctrine of chances. But this, perhaps, will be more clearly exemplified in the two following problems, which will serve to explain the principles on which every other investigation is founded in this subject.

Prob. 1. To determine the probability that an event happens a given number of times and no more, in a given number of trials.

Sol. 1. Let the probability be required of its happening only once in two trials, and let the ratio of its happening to that of its failing be as a to b. Then since the event can take place only by it happening the first, and failing the second time, the probability of which is $\frac{a}{a+b} \times \frac{b}{a+b} = \frac{ab}{\overline{a+b}|^2}$, or by its failing the first and happening the second time, the probability of which is $\frac{ba}{\overline{a+b}|^2}$, the sum of these two fractions, or $\frac{2ab}{\overline{a+b}|^2}$ will be the probability required.

2. Let the probability be required of its happening only twice in three trials. In this case, the event, if it happens, must take place in either of three different ways: 1st, by its happening the first two, and failing the third time, the probability of which is $\frac{aab}{\overline{a+b}|^3}$; 2dly, by its failing the first and happening the other two times, the probability of which is $\frac{baa}{\overline{a+b}|^3}$; or, 3dly, by its happening the first and third, and failing the second time, the probability of which is $\frac{aba}{\overline{a+b}|^3}$. The sum of these fractions, therefore, or $\frac{3baa}{\overline{a+b}|^3}$, will be the required probability. By the same method of reasoning the probability of its happening only once in three trials; or, which is the same thing, of its

failing twice in three trials, may be found equal to $\frac{3bba}{\overline{a+b}|^3}$.

3. Let the probability of the event's happening only once in four trials be required. In this case it must either happen the first and fail in the three succeeding trials; or happen the second and fail in the first, third, and fourth trials; or happen the third, and fail in the first, second, and fourth trials; or happen the fourth, and fail in the first, second, and third trials. The probability of each of these being $\frac{ab^3}{\overline{a+b}|^4}$, the required probability will be $\frac{4ab^3}{\overline{a+b}|^4}$; and for the same reason the probability of its happening three times and failing only once in four trials will be $\frac{4ba^3}{\overline{a+b}|^4}$.

4. Let the probability be required of its happening twice and failing twice in four trials: here the event may be determined in either of six different ways: 1st, by its happening the first and second, and failing in the third and fourth trials; 2dly, by its happening the first and third, and failing the second and fourth trials; 3dly, by its happening the first and fourth, and failing the second and third trials; 4thly, by its happening the second and third, and failing the first and fourth trials; 5thly, by its happening the second and fourth, and failing the first and third trials; or, 6thly, by its happening the third and fourth, and failing the first and second trials. Each of these probabilities being expressed by $\frac{a^2b^2}{\overline{a+b}|^4}$, it follows that the sum of them, or $\frac{6a^2b^2}{\overline{a+b}|^4}$ will express the probability required.

By proceeding in the same manner, the probability in any other case may be determined. But if the number of trials be very great these operations will become exceedingly complicated, and therefore recourse must be had to a more general method of solution.

Supposing n to be the whole number of trials, and d the number of times in which the event is to take place, the probability of the event's happening d times successively, and failing the remaining $n\,d$ times, will be $\frac{a^d}{\overline{a+b}|^d} \times \frac{b^{n-d}}{\overline{a+b}|^{n-d}} = \frac{a^d . b^{n-d}}{\overline{a+b}|^n}$. But as there is the same probability of its happening any other d assigned trials and failing in the rest, it is evident that this probability ought to be repeated as often as d things can be combined in n things, which, by the known rules of combination, are $= \frac{n.}{1} \times \frac{n-1}{2} \times \frac{n-2}{3}$ continued to d terms; the general rule therefore will be $\frac{a^d . b^{n-d}}{\overline{a+b}|^n}$ multiplied into $n \times \frac{n-1}{2} \times \frac{n-2}{3} \times \frac{n-3}{4}$ continued to d terms.

Ex. Supposing a person with six dice undertakes to throw two aces and no more; or, which is the same thing, that he undertakes with one die to throw an ace twice, and no more, in six trials, it is required to determine the probability of his succeeding, a being in this case $= 1$, $b = 5$, $n = 6$, and $d = 2$, the above expressions will become $= \frac{5^4}{6^6}$, multiplied into $6 \times \frac{5}{2} = \frac{625 \times 15}{46656} = \frac{1}{5}$ very nearly. Hence since there is only one chance for his succeeding, while there are four for his failing, the odds against him will be as four to one.

Prob. 2. To determine the probability that an event happens a given number of times in a given number of trials; supposing, as in the former problem, the probability of its happening each time to that of its failing to be in the ratio of a to b.

Sol. It will be observed that this problem materially differs from the preceding, in as much as the event in that problem was restrained so that it should happen neither more or less often than a given number of times, while in this problem the event is determined equally favourable by its happening either as often or oftener than a given number of times, so that in the present case there is no further restriction than that it should not fall short of that number.

1. Let the probability be required of an event happening once at least in two trials. If it happens the first and fails the second time, or fails the first and happens the second time, or happens both times, the event will have equally succeeded. The probability in the first case is $\frac{ab}{\overline{a+b}|^2}$, the probability in the second is $\frac{ba}{\overline{a+b}|^2}$, and the probability in the third is $\frac{aa}{\overline{a+b}|^2}$; hence the

probability required will be $= \frac{2ab + aa}{\overline{a+b}|^2}$.

2. Let the probability be required of its happening once in three times. Provided it has happened once at least in the first two trials, the event will have equally succeeded, whether it happens or fails in the third trial, and therefore $\frac{a^2+2ab}{\overline{a+b}|^2}$ will represent the probability in this case. But it may have failed in the first two and happened in the third trial, the probability of which is $\frac{bba}{\overline{a+b}|^3}$; adding this to the preceding fraction we have $\frac{\overline{a^2+2ab}\times\overline{a+b}+b^2a}{\overline{a+b}|^3} = \frac{a^3+3a^2b+3ab^2}{\overline{a+b}|^3}$ for the probability required. In like manner the probability of its happening once at least in four trials will be $\frac{a^3+3a^2b+3abb}{\overline{a+b}|^3} + \frac{ab^3}{\overline{a+b}|^4} = \frac{a^4+6a^3b+6a^2b^2+4ab^3}{\overline{a+b}|^4}$, and the probability of its happening once at least in n times will be $= \frac{\overline{a+b}|^n - b^n}{\overline{a+b}|^n}$. In other words, since the event must happen once at least, unless it fails every time, the probability required (by Def. 1) will always be expressed by the difference between unity and $\frac{b^n}{\overline{a+b}|^n}$.

3. Let the probability be required of an event's happening twice at least in three trials. In this case it will succeed if it happens the first and second, and fails the third time, if it happens the first and third, and fails the second time, if it happens the second and third, and fails the first time, or if it happens each time successively. The first three probabilities are $\frac{3a^2b}{\overline{a+b}|^3}$, and the fourth is $\frac{a^3}{\overline{a+b}|^3}$; therefore the probability required will be $= \frac{a^3+3a^2b}{\overline{a+b}|^3}$. If the event is to happen twice at least in four times, the probability of its happening during the first three times has been already found. Let it be supposed to have happened only once in these times, the probability of which, by the preceding problem, is $\frac{3abb}{\overline{a+b}|^3}$; then will the probability of its happening the fourth, after having happened once in the three preceeding, be $\frac{3a^2b^2}{\overline{a+b}|^4}$, and therefore the whole probability will be $\frac{a^3+3a^2b}{\overline{a+b}|^3} + \frac{3a^2b^2}{\overline{a+b}|^4} = \frac{a^4+4a^3b+6a^2b^2}{\overline{a+b}|^4}$. By proceeding in the same manner, it may be found that the probability of an event's happening twice at least in five trials, will be $= \frac{a^4+4a^3b+6a^2}{\overline{a+b}|^4} + \frac{a}{a+b} \times \frac{4ab^3}{\overline{a+b}|^4} = \frac{a^5+5a^4b+10a^3b^2+10a^2b^2}{\overline{a+b}|^5}$. And if the probability of the event's happening thrice in four, five, six, &c. trials be required, they may, by pursuing the same steps, be found $= \frac{a^4+4a^3b}{\overline{a+b}|^4}, \frac{a^5+5a^4b+10a^3b^2}{\overline{a+b}|^5}, \frac{a^6+6a^5b+15a^4b^2+20a^3b^3}{\overline{a+b}|^6}$, &c. respectively. Hence it follows, that if the binomial $\overline{a+b}|$ be raised to nth power, the probability of an event's happening at least d times in n trials will be $=$

$$\frac{a^n + na^{n-1}b + n.\frac{n-1}{2}.a^{n-2}b^2\,(\overline{n+1}-d)}{\overline{a+b}|^n}$$

that is, the series in the numerator must be continued till the index of a becomes equal to d.

Cor. From this solution it appears that the series $\frac{b^n + nb^{n-1}a + n.\frac{n-1}{2}b^{n-2}a^2 \text{ to } d \text{ terms}}{\overline{a+b}|^n}$ will express the probability of the event's not happening so often as d times in n trials.

Ex. Supposing a person with six dice undertakes to throw two aces or more in the first trial, what is the probability of his succeeding? In this case a, b, n, and d, being respectively equal to 1, 5, 6, and 2, the above expression will become $=$

$$\frac{1+30+15\times25+20\times125+15\times625}{6^6}$$

$= \frac{12281}{46656}$. Hence the odds against his succeeding will be as 34375 to 12281, or nearly as three to one.

We have already observed, that the doctrine of chances is particularly applicable to the business of life annuities and assurance. This depends on the chance of life in all its stages, which is found by the bills of mortality in different places. These bills exhibit how many persons upon an average out of a certain number born are left at the end of each year to the extremity of life

From such tables the probability of the continuance of a life of any proposed age is known.

Example. To find the probability that an individual of a given age will live one year. Let A be the number in the tables of the given age, B the number left at the end of the year; the $\frac{B}{A}$ is the probability that the individual will live one year; and $\frac{A-B}{A}$ the probability that he will die in that time. In Dr. Halley's tables, out of 586 at the age of 22, 579 arrive at the age of 23; hence the probability that an individual aged 22 will live one year is $\frac{579}{586}$, or $\frac{83}{84}$ nearly; and $\frac{7}{586}$, or $\frac{1}{84}$ nearly is the probability that he will die in that time. See Mortality, *bills of*, &c.

Those who would enter more at large into this subject may be referred to the works already mentioned, or to the article Chances in the new Cyclopedia of Dr. Rees, a work that will be found in every library of general literature, and in which this subject is treated with great ability. Though we shall under the article Gaming refer again to the doctrine of chances, it may not be amiss to mention a deduction or two drawn by the writer of the article just referred to, as the necessary consequences of mathematical reasoning. The first is: supposing a lottery consisting of 25,000 tickets, of which 20 are to be prizes of 1000*l.* and upwards; a person to have an equal chance of one of those prizes must purchase about 870 tickets, which at 20*l.* each is equal to 17,400*l.*

Again: suppose there are three prizes of 20,000*l.* and three of 10,000*l.* and a person out of 25,000 tickets has purchased 3000 of them to his own share, in hopes of gaining one of each of these capital prizes; still the chances against such an expectation will be nearly twelve to one. See Gaming.

Chance-*medley*, in law, is the accidental killing of a man, not altogether without the killer's fault, though without any evil intention; and is where one is doing a lawful act, and a person is killed thereby: for, if the act be unlawful, it is felony. The difference betwixt chance-medley and manslaughter is this: if a person cast a stone, which happens to hit one, and he dies; or if a workman, in throwing down rubbish from a house, after warning to take care, kill a person, it is chance-medley and misadventure: but if a person throws stones on the highway, where people usually pass; or a workman throws down rubbish from a house in cities and towns where people are continually passing; or if a man whips his horse in the street, to make him gallop, and the horse runs over a child and kills it, it is manslaughter: but if another whips the horse, it is manslaughter in him, and chance-medley in the rider. In chance-medley the offender forfeits his goods, but has a pardon of course.

CHANCELLOR, an officer supposed originally to have been a notary or scribe under the emperors, and named *cancellarius*, because he sat behind a lattice, called in Latin *cancellus*, to avoid being crowded by the people.

Chancellor, *Lord High, of Great Britain*, or *Lord Keeper of the Great Seal*, is the highest honour of the long robe, being made so *per traditionem magni sigilli, per dominum regem*, and by taking the oaths: he is the first person of the realm next after the king and princes of the blood in all civil affairs; and is the chief administrator of justice next the sovereign, being the judge of the court of chancery. All other justices are tied to the strict rules of law in their judgment; but the chancellor is invested with the king's absolute power, to moderate the written law, governing his judgment purely by the law of nature and conscience, and ordering all things according to equity and justice. The Lord Chancellor not only keeps the King's great seal; but also all patents, commissions, warrants, &c. from the King, are, before they are signed, perused by him: he has the disposition of all ecclesiastical benefices in the gift of the crown under 20*l.* a year in the King's books; and he is speaker of the House of Lords. To him belongs the appointment of all justices of the peace throughout the kingdom. He is the general guardian of all infants, idiots, and lunatics; and has the general superintendence of all charitable uses in the kingdom.

Chancellor *of a cathedral*, an officer that hears lessons and lectures read in the church, either by himself or his vicar; to correct and set right the reader when he reads amiss; to inspect schools; to hear causes; apply the seal, write and dispatch the letters of the chapter; keep the books; take care that there be frequent preachings both in the church and out of it; and assign the office of preaching to whom he pleases.

Chancellor *of the duchy of Lancaster*,

an officer appointed chiefly to determine controversies between the king and his tenants of the duchy land, and otherwise to direct all the King's affairs belonging to that court.

CHANCELLOR *of the Exchequer*, an officer who presides in that court, and takes care of the interest of the crown.

He is always in commission with the Lord Treasurer, for the letting of crown-lands, &c. and has power, with others, to compound for forfeitures of lands, upon penal statutes: he has also great authority in managing the royal revenues, and in matters relating to the first fruits.

CHANCELLOR *of the order of the garter, and other military orders*, is an officer who seals the commissions and mandates of the chapter and assembly of the knights, keeps the register of their proceedings, and delivers acts thereof under the seal of their order.

CHANCELLOR *of an university*, is he who seals the diplomas, or letters of degrees, provision, &c. given in the university. The Chancellor of Oxford is usually one of the prime nobility, chosen by the students themselves in convocation. He is their chief magistrate; his office is *durante vita*, to govern the university, preserve and defend its rights and privileges, convoke assemblies, and do justice among the members under his jurisdiction. Under the Chancellor is the Vice-Chancellor, who is chosen annually, being nominated by the Chancellor, and elected by the university in convocation: he is always the head of some college, and in holy orders. His proper office is to execute the Chancellor's power, to govern the university according to her statutes, to see that officers and students do their duty, that courts be duly called, &c. When he enters upon his office, he chooses four Pro-Vice-Chancellors out of the heads of the colleges, to execute his power in his absence. The Chancellor of Cambridge is also usually one of the prime nobility, and in most respects the same as that in Oxford, only he does not hold his office *durante vita*, but may be elected every three years. Under the Chancellor there is a Commissary, who holds a court of record for all privileged persons and scholars under the degree of Master of Arts, where all causes are tried and determined by the civil and statute law, and by the custom of the university. The Vice-Chancellor of Cambridge is chosen annually by the senate, out of two persons nominated by the heads of the several colleges and halls.

CHANCERY, the grand court of equity and conscience, instituted to moderate the rigour of the other courts that are bound to the strict letter of the law.

In Chancery are two courts; one ordinary, being a court of common law; the other extraordinary, being a court of equity. The ordinary or common law court, is a court of record. Its jurisdiction is to hold plea upon a *scire facias*, to repeal and cancel the King's letters patent, when made against law, or upon untrue suggestions; and to hold plea on all personal actions, where any officer of this court is a party; and of executions on statutes, or of recognizances in nature of statutes; and by several acts of Parliament, of diverse other offences and causes; but this court cannot try a cause by a jury, but the record is to be delivered by the Lord Chancellor into the King's Bench, to be tried there and judgment given thereon. And when judgment is given in this common law part of Chancery upon demurrer, or the like, a writ of error is returnable into the King's Bench; but this hath not been practised for many years. From this court also proceed all original writs, commissions of charitable uses, bankrupts, sewers, idiots, lunatics, and the like: and for these ends this court is always open.

The extraordinary court is a court of equity, and proceeds by the rules of equity and good conscience. This equity consists in abating the rigour of the common law, and giving a remedy in cases where no provision, or not sufficient provision, had been made by the ordinary course of law. The jurisdiction of this court is of vast extent. Almost all causes of weight and moment, first or last, have their determination here. In this court relief is given in the case of infants, married women, and others not capable of acting for themselves. All frauds for which there is no remedy at law, are cognizable here; as also all breaches of trust, and unreasonable or unconscionable engagements. It will compel men to perform their agreements; will remove mortgageors and obligors against penalties and forfeiture, on payment of principal, interest, and costs; will rectify mistakes in conveyances; will grant injunctions to stay waste; and restrain the proceedings of inferior courts, that they exceed not their authority and jurisdiction. This court will not retain a suit for any thing under 10*l.* value,

except in cases of charity, nor for lands under 40*s. per annum.*

CHANCRE. See SURGERY.

CHANGES, in arithmetic, the variations or permutations of any number of things, with regard to their position, order, &c. The method of finding out the number of changes, is by a continual multiplication of all the terms in a series of arithmetical progressionals; whose first term, and common difference, is unity, or 1; and last term the number of things proposed to be varied; *viz.* $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7$, &c. as will appear from what follows:

1. If the things proposed to be varied are only two, they admit of a double position, as to order of place, and no more.

Thus, $\left\{\begin{matrix}1.2\\2.1\end{matrix}\right\} = 2 = 1 \times 2.$

2. And if three things are proposed to be varied, they may be changed six several ways, as to their order of places, and no more.

For, beginning with 1, there will be .... $\left\{\begin{matrix}1.2.3\\1.3.2\end{matrix}\right.$

Next, beginning with 2, there will be .... $\left\{\begin{matrix}2.1.3\\2.3.1\end{matrix}\right.$

Again, beginning with 3, it will be .... $\left\{\begin{matrix}3.1.2\\3.2.1\end{matrix}\right.$

Which, in all, make 6, or 3 times 2; *viz.* $1 \times 2 \times 3 = 6.$

3. Suppose 4 things were supposed to be varied, then they admit of 24 several changes, as to their order of different places.

For, beginning the order with 1, it will be ....
Here are 6 different changes.
$\left\{\begin{matrix}1.2.3.4\\1.2.4.3\\1.3.2.4\\1.3.4.2\\1.4.2.3\\1.4.3.2\end{matrix}\right.$

And for the same reason there will be 6 different changes when 2 begins the order, and as many when 3 and 4 begin the order; which, in all, is $24 = 1 \times 2 \times 3 \times 4$. And, by this method of proceeding, it may be made evident, that 5 things admit of 120 several variations or changes; and 6 things, of 720.

Thus, if it be required, in how many different ways seven persons may be placed at table, the answer is $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 = 5040$. The following table will shew the several variations and changes of any number of things up to 12.

The number of things to be varied.	How the variations are produced.	The different variations each of the proposed numbers can admit of.
1......	1×1	$=1$
2......	1×2	$=2$
3......	2×3	$=6$
4......	6×4	$=24$
5......	24×5	$=120$
6......	120×6	$=720$
7......	720×7	$=5040$
8......	5040×8	$=40320$
9......	40320×9	$=362880$
10......	362880×10	$=3628800$
11......	3628800×11	$=39916800$
12......	39916800×12	$=479001600$

They may be thus continued on to any assigned number. Suppose to 24, the number of letters in the alphabet, which will admit of 620448401733239439360000 several variations.

Since on 12 bells there would be, by the table, 479001600 changes: suppose 10 changes to be rung in a minute, that is 10×12, or 120 strokes in a minute, it would even then require upwards of 90 years to ring over all the changes on the 12 bells.

CHANGES *of quantities*, in algebra, the same with what is otherwise called combination. See COMBINATION.

CHANNEL, in hydrography, the deepest part of a river, harbour, strait, &c. which is most convenient for the track of shipping; also an arm of the sea running between an island and the main or continent, as the British Channel.

CHAOS, in natural history, a genus of insects, belonging to the order Zoophyta. The body has no covering; no joints; no external organs of sensation. There are five species, most obtained by infusion of different vegetables in water, and seen only by the aid of the microscope.

CHAPLAIN, an ecclesiastic who officiates in a chapel. The King of Great Britain hath forty-eight chaplains in ordinary, usually eminent doctors in divinity, who wait four each month, preach in the chapel, read the service to the family, and to the King in his private oratory, and say grace in the absence of the clerk of the closet. Besides, there are twenty-four chaplains at Whitehall, fellows of Oxford or Cambridge, who preach in their turns, and are allowed thirty pounds *per annum* each. According to a statute of Hen. VIII. the persons vested with a power of retain-

ing chaplains, together with the number each is allowed to qualify, is as follows: an archbishop, eight; a duke or bishop, six; marquis or earl, five; viscount, four; baron, knight of the garter, or lord chancellor, three; a duchess, marchioness, countess, baroness, the treasurer and comptroller of the king's house, clerk of the closet, the king's secretary, dean of the chapel, almoner and master of the rolls, each of them two; chief justice of the King's Bench, and warden of the Cinque Ports, each one. All these chaplains may purchase a license or dispensation, and take two benefices with cure of souls. A chaplain must be retained by letters testimonial under hand and seal; for it is not sufficient that he serve as chaplain in the family.

CHAPLET, in architecture, a small ornament carved into round beads, pearls, olives, and pater-nosters, as is frequently done in baguettes.

CHAPPE, in heraldry, the dividing an escutcheon by lines drawn from the centre of the upper edge to the angles below, into three parts, the sections on the sides being of a different metal or colour from the rest.

CHAPTER, in ecclesiastical policy, a society or community of ecclesiastics belonging to a cathedral or collegiate church.

It was in the eighth century that the body of canons began to be called a chapter. The chapter of the canons of a cathedral were a standing council to the bishop, and during the vacancy of the see, had the jurisdiction of the diocese. In the earlier ages, the bishop was head of the chapter; afterwards abbots and other dignitaries, as deans, provosts, treasurers, &c. were preferred to this distinction. The deans and chapters had the privilege of choosing the bishops in England, but Henry VIII. got this power vested in the crown: and as the same prince expelled the monks from the cathedrals, and placed secular canons in their room, those he thus regulated were called deans and chapters of the new foundation; such are Canterbury, Winchester, Ely, Carlisle, &c.

CHARA, in botany, a genus of the Monoecia Monandria class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: male, calyx and corolla none; anther before the germ, underneath. Female, calyx four-leaved; corolla none; stigma five-cleft; seed one. There are four species, of which C. tomentosa, brittle chara, or stone wort, is always flesh-coloured when alive, and when dry it becomes ash-coloured; stem twisted, brittle, and gritty in the mouth like coralline; low and creeping in marshes where there is little water. In summer this plant abounds in oblong berries, growing yellow when ripe, having small black seeds in them. It is an annual, flowering from June to October.

CHARACTER, in a general sense, denotes any mark whatever, serving to represent either things or ideas; thus, letters are characters, types, or marks of certain sounds, words, of ideas, &c.

Characters are of infinite advantage in almost all sciences, for conveying in the most concise and expressive manner an author's meaning; however, such a multiplicity of them, as we find used by different nations, must be allowed to be a very considerable obstacle to the improvement of knowledge; several authors have therefore attempted to establish characters that should be universal, and which each nation might read in their own language; and, consequently, which should be real, not nominal or arbitrary, but expressive of things themselves; thus, the universal character for a horse would be read by an Englishman *horse*, by a Frenchman *cheval*, by the Latins *equus*, by the Greeks *ιππος*, &c.

The first who made any attempts for an universal character in Europe, were Bishop Wilkins and Dalgarme; Mr. Leibnitz also turned his thoughts that way; and Mr. Lodwic, in the Philosophical Transactions, gives a plan of an universal character, which was to contain an enumeration of all such single sounds as are used in any language. The advantages he proposed to derive from this character were, that people would be enabled to pronounce truly and readily any language that should be pronounced in their hearing; and lastly, that this character would serve as a standard to perpetuate the bounds of every language whatsoever.

CHARACTER is also used in several of the arts, for a symbol, contrived for the more concise and immediate conveyance of the knowledge of things. We shall here subjoin the principal of them.

CHARACTERS *used in algebra and arithmetic.*

a, b, c, d, &c. the first letters of the alphabet, are the characters of given quantities; and z, y, x, &c. the last letters, are the characters of quantities sought. See the article ALGEBRA.

m, n, r, s, t, &c. are characters of indeterminate exponents both of ratios and of

powers: thus, x^m, y^n, z^r, &c. denote undetermined powers of different kinds; mx, ny, rz, different multiples or submultiples of the quantities x, y, z, according as m, n, r, are either whole numbers or fractions.

$+$ is the sign of the real existence of the quantity it stands before, and is called an affirmative or positive sign. It is also the mark of addition, and is read plus, or more; thus $a+b$, or $3+5$, implies a is added to b, or 3 added to 5.

$-$ before a single quantity is the sign of negation or negative existence, shewing the quantity to which it is prefixed to be less than nothing. But between quantities it is the sign of subtraction, and is read minus, or less; thus, $a-b$, or $8-4$, implies b subtracted from a, or 8 after 4 has been subtracted.

$=$ is the sign of equality, though Des Cartes and some others use this mark ∞; thus, $a=b$ signifies that a is equal to b. Wolfius and some others use the mark $=$ for the identity of ratios.

$\times$ is the sign of multiplication, shewing that the quantities on each side the same are to be multiplied by one another, as $a \times b$ is to be read a multiplied into b; 4×8, the product of 4 multiplied into 8. Wolfius and others make the sign of multiplication a dot between the two factors; thus, $5 . 4$ signifies the product of 5 and 4. In algebra the sign is commonly omitted, and the two quantities put together; thus bd expresses the product of b and d. When one or both of the factors are compounded of several letters, they are distinguished by a line drawn over them; thus, the factum of $a+b-c$ into d, is wrote $d \times \overline{a+b-c}$. Leibnitz, Wolfius, and others, distinguish the compound factors by including them in a parenthesis; thus, $(a+b-c)\,d$.

$\div$ is the sign of division; thus, $a \div b$ denotes the quantity a to be divided by b. In algebra the quotient is often expressed like a fraction; thus, $\frac{a}{b}$ denotes the quotient of a divided by b. Wolfius makes the sign of division two dots; thus, $12:4$ denotes the quotient of 12 divided by $4=3$. If either the divisor or dividend, or both, be composed of several letters, for example, $a+b \div c$, instead of writing the quotient like a fraction, $\frac{a+b}{c}$, Wolfius includes the compound quantities in a parenthesis; thus, $(a+b):c$.

⊛ is the character of involution: ɯ is the character of evolution.

⌐ or ⊏ are signs of majority; thus a ⌐ b expresses that a is greater than b.

⌐ or ⊐ are signs of minority; and when we would denote that a is less than b, we write a ⌐ b, or a ⊐ b.

∽ is the character of similitude used by Wolfius, Leibnitz, and others: it is used in other authors for the difference between two quantities while it is unknown which is the greater of the two.

$::$ is the mark of geometrical proportion disjunct, and is usually placed between two pair of equal ratios, as, $3:6::4:8$, shews that 3 is to 6 as 4 is to 8.

∺ the mark of geometrical proportion continued, implies the ratio to be still carried on without interruption, as, 2, 4, 8, 16, 32, 64 ∺ are in the same uninterrupted proportion.

$\surd$ is the character of radicality, and shews, according to the index of the power that is set over it, or after it, that the square, cube, or other root is extracted, or to be extracted; thus, $\surd 16$, or $\surd^2 16$, or $\surd(2)\,16$, is the square root of 16, $\sqrt[3]{25}$, the cube root of 25, &c. This character sometimes affects several quantities, distinguished by a line drawn over them; thus, $\sqrt{b+d}$ denotes the sum of the square roots of b and d. When any term or terms of an equation are wanting, they are generally supplied by one or more asterisms; thus, in the equation $\left.\begin{array}{l} y^2+py+\frac{1}{4}p^2+q \\ \quad -py-\frac{1}{2}p^2 \end{array}\right\} = 0$, the term $\pm py$ vanishing, is marked with an asterism, as $y^2 * -\frac{1}{4}p^2+q$.

CHARACTERS used in astronomy.

Characters of the planets

♄ Saturn	☉ Sun	☾ Moon
♃ Jupiter	♀ Venus	⊕ Earth.
♂ Mars	☿ Mercury	

Of the signs.

♈ Aries	♌ Leo	♐ Sagittarius
♉ Taurus	♍ Virgo	♑ Capricornus
♊ Gemini	♎ Libra	♒ Aquarius
♋ Cancer	♏ Scorpio	♓ Pisces.

Of the aspects.

☌ or S. Conjunction	△ Trine
SS. Semisextile	Bq. Biquintile
⚹ Sextile	Vc. Qgincunx
Q. Quintile	☍ Opposition
□ Quartile	☊ Dragon's head
Td. Tredecile	☋ Dragon's tail.

Of time.

A. M. *ante meridiem*, before the sun comes upon the meridian.

O. or N. noon.

P. M. *post meridiem,* when the sun is past the meridian.

CHARACTERS used in the arithmetic of infinites.

. the character of an infinitesimal or fluxion; thus, $\dot{x}$, $\dot{y}$, &c. express the fluxions or differentials of the variable x and y; and two, three, or more dots denote second, third, or higher fluxions. M. Leibnitz, instead of a dot, prefixes the letter d to the variable quantity, in order to avoid the confusion of dots in the differencing of differentials. See CALCULUS DIFFERENTIALIS.

CHARACTERS in medicine and pharmacy.

℞ recipe	ß, or *ss*, half of any thing
ā, āā, or ana, of each alike	cong. congius, a gallon
℔ a pound or a pint	coch. cochleare, a spoonful
℥ an ounce	M. manipulus, a handful
ʒ a drachm	q. pl. as much as you please
℈ a scruple	P. P. pulvis patrum, the Jesuit's bark.
gr. grains	
P. a pugil	
P. Æ. equal quantities	
S. A. according to art	
q. s. a sufficient quantity.	

CHARACTERS used in music, and of musical notes, with their proportions, are as follow:

character of a large ... 8	minim ... $\frac{1}{2}$
a long ... 4	crotchet ... $\frac{1}{4}$
a breve ... 2	quaver ... $\frac{1}{8}$
a semibreve ... 1	semiquaver ... $\frac{1}{16}$
	demisemiquaver $\frac{1}{32}$

♯ character of a sharp note: this character, at the beginning of a line or space, denotes that all the notes in that line are to be taken a semitone higher than in the natural series; and the same affects all the octaves above or below, though not marked; but when prefixed to any particular note it shows that note alone to be taken a semitone higher than it would be without such character.

♭ or *b*, character of a flat note: this is the contrary to the other above, that is, a semitone lower.

♮ character of a natural note: when in a line or series of artificial notes, marked at the beginning ♭ or ♯, the natural note happens to be required, is is denoted by this character.

𝄞 character of the treble cliff.

𝄡 character of the mean cliff.

𝄢 bass cliff.

2, or $\frac{2}{4}$, or $\frac{4}{8}$, characters of common duple time: signifying the measure of two crotchets to be equal to two notes, of which four make a semibreve.

C ₵ Ↄ characters that distinguish the movements of common time, the first implying slow, the second quick, and the third very quick.

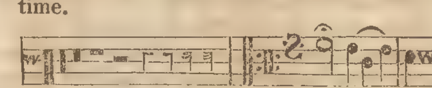
$\frac{1}{2}$, $\frac{3}{2}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{3}{16}$, characters of simple triple time, the measure of which is equal to three semibreves, or to three minims.

$\frac{6}{4}$, or $\frac{6}{8}$, or $\frac{6}{16}$, characters of mixed triple time, where the measure is equal to six crotchets or six quavers.

$\frac{9}{4}$, or $\frac{9}{8}$, or $\frac{9}{16}$, or $\frac{9}{1}$, or $\frac{9}{2}$, characters of compound triple time.

$\frac{12}{4}$, $\frac{12}{8}$, $\frac{12}{16}$, or $\frac{12}{1}$, or $\frac{12}{2}$, characters of that species of triple time called the measure of twelve times.

CHARACTERS of the rests or pauses of time.



CHARACTERS, *numeral,* used to express numbers, are either letters or figures. The Arabic character, called also the common one, because it is used almost throughout Europe in all sorts of calculations, consists of these ten digits, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

The Roman numeral character consists of seven majuscule letters of the Roman alphabet, *viz.* I, V, X, L, C, D, M. The I denotes one, V five, X ten, L fifty, C a hundred, D five hundred, and M a thousand.

The I repeated twice makes two, II; thrice, three, III; four is expressed thus, IV, as I before V or X takes an unit from the number expressed by these letters. To express six an I is added to a V, VI; for seven, two, VII; and for eight, three, VIII: nine is expressed by an I before X, thus, IX.

The same remark may be made of the X before L or C, except that the diminution is by tens; thus, XL denotes forty, XC ninety, and LX sixty. The C before D or M diminishes each by a hundred.

The number five hundred is sometimes expressed by an I before a C inverted, thus

IↃ; and instead of M, which signifies a thousand, an I is sometimes used between two C's, the one direct and the other inverted, thus CIↃ. The addition of C and Ↄ before or after, raises CIↃ by tens, thus CCIↃↃ expresses ten thousand, CCCIↃↃↃ a hundred thousand. The Romans also expressed any number of thousands by a line drawn over any numeral less than a thousand; thus, $\overline{\text{V}}$ denotes five thousand, $\overline{\text{LX}}$ sixty thousand; so likewise $\overline{\text{M}}$ is one million, $\overline{\text{MM}}$ is two millions, &c.

The Greeks had three ways of expressing numbers: first, every letter, according to its place in the alphabet, denoted a number, from α, one, to ω, twenty-four. 2. The alphabet was divided into eight units, α one, β two, γ three, &c. into eight tens, ι ten, κ twenty, λ thirty, &c. and eight hundreds, ρ one hundred, σ two hundred, τ three hundred, &c. 3. Ι stood for one, Π (πεντε) five, Δ (δεκα) ten, Η (Ηκατον) a hundred, Χ (χιλια) a thousand, Μ (μυρια) ten thousand; and when the letter Π inclosed any of these, except Ι, it showed the inclosed letter to be five times its value; as $\boxed{\Delta}$ fifty, $\boxed{\text{H}}$ five hundred, $\boxed{\text{X}}$ five thousand, $\boxed{\text{M}}$ fifty thousand.

The Hebrew numerals consisted of their alphabet divided into nine units; thus, א one, ב two, &c.: nine tens; thus, י ten, כ twenty, &c.: nine hundreds; thus, ק one hundred, ר two hundred, &c.: and ך five hundred, ם six hundred, ן seven hundred, ף eight hundred, ע nine hundred. They expressed thousands by the word אלף, with the other numerals prefixed to signify the number of thousands: thus, אלפים, two thousand, גאלפים, three thousand, &c.

Characters upon tomb-stones.

S. V. Siste viator, *i. e.* Stop, traveller.

M. S. Memoriæ sacrum, *i. e.* Sacred to the memory.

Character, in law, if a person apply to another for the character of a third person, and a good character as to his solvency be given, yet if, in consequence of this opinion, the party asking the question suffer loss through the person's insolvency, no action lies against him who gave the character, if it were fairly given. But if a man assert what he knows to be false, and thereby draws his neighbour into a loss, it is actionable. But if the party giving credit also knew that the party credited was in bad circumstances, an action will not lie.

Characters, in botany, the description of the genera of plants so termed by Linnæus; hence the generic character of any plant, and the definition of the genus, are synonymous terms. The term character is not extended by that author to the species of plants, because he never gives the complete description of any species; but only enumerates those characters or circumstances in which it differs from all the other species of the same genus. This observation sufficiently illustrates the different methods which are observed in the Genera and Species Plantarum. In the former work, all the parts of the flower and fruit, from which the characters of the genera are derived, are accurately and completely described; in the latter, such striking circumstances only of the stem, leaves, buds, roots, &c. are mentioned, as sufficiently distinguish the species in question from every other of that genus to which it belongs.

In general, characters, or characteristical marks, according to the idea of systematic writers, are certain external signs obvious in the appearance of natural bodies, by means of which they are distinguished from one another. These signs being collected and expressed by proper words, lay the foundation at once for definition, distribution, and denomination, the three grand parts of practical botany. The characteristic mark of each genus is to be fixed from the figure, situation, connection, number, and proportion of all the parts. Any part of a body considered either in itself, or with relation to others, is found to possess all the properties just enumerated. Characters, therefore, may be drawn from all the parts to define the difference of bodies; thus the leaf, stem, flower, and its parts, in plants; the foot, wing, fin, in animals; all differ in their figure, situation, number, and proportion, and exhibit characters proper for distinction. Experience shows that one part, or property of a part, varies more than another; in constituting a method, therefore, those parts and properties are to be selected which vary least. Thus the parts of flowers in vegetables, the feet, fins, beaks, in animals, are more fixed with respect to the above-mentioned properties. Again, the figure and number of these parts are more apt to vary than their situation, connection, and proportion; the characters, therefore, are, if possible, to be taken from these last.

Artificial Character.—The artificial character, otherwise called accidental, and, by

Linnæus, factitious, is drawn indiscriminately from different parts of the plant, and admits of fewer or more characteristical marks than are absolutely necessary for distinguishing the classes, genera, and species. Linnæus, who particularly applies all the characters just enumerated to the distribution of the genera, establishes for a criterion of the artificial character, that it can never distinguish the genera in a natural order; being calculated merely for discriminating such as arrange themselves under the same artificial order. To the head of artificial characters is referred, by Linnæus, the description of the genera, in the methods of Tournefort, Ray, Rivinus, Boerhaave, and most of the other systematic botanists. The classical characters only, in the sexual method, are deemed artificial: the generical, as exhausting the description of the parts of fructification, its author considers, as true natural characters.

Linnæus's idea of an artificial character is well expressed by Ray, when he says, that no more characteristical marks of the genera are to be collected, than are found absolutely necessary for determining the genus with certainty and precision.

Essential Character.—The essential character discriminates one plant from another by means of a single mark, so striking and particular, as to distinguish the plant in which it is found from every other at first sight. It serves, says Linnæus, to distinguish such genera as arrange themselves under the same natural order. The essential character of the classes and genera, by the consent of all the modern systematic botanists, ought to be drawn from one of the seven parts of fructification; that of the species from any of the other parts, as the stem, leaf, root, buds, &c.

Natural character.—This character includes the two former, and collects all the possible marks of plants. It is useful, says Linnæus, in every method; lays the foundation of the systems; remains unchanged, although new genera be daily discovered; and is capable of emendation by the detection of new species alone, which afford an opportunity of excluding such characteristical marks as are totally superfluous. He adds, that the Genera Plantatum first introduced these characters into the science.

CHARADRIUS, or the *plover*, in natural history, a genus of birds of the order Grallæ. Generic character: bill straight, and in general about the length of the head; nostrils linear; three toes, and all placed forward. There are twenty-six species, of which the most interesting are the following.

C. pluvialis, or the golden plover. This species inhabits Great Britain during the whole of the year, frequenting particularly the Grampian Hills and the mountains of the Hebrides. Their length is about ten inches and a half. They make a shrill noise like that of a whistle, by the imitation of which they are easily decoyed within reach of the gun.

C. himantopus, or long legged plover, is occasionally to be found in England, though now but rarely. It is common in Egypt, where its food consists of flies. It is most characteristically designated, as the length of its legs is most extraordinary.

C. hiaticula, or ringed plover, arrives in England in the spring, and leaves it in autumn. During the summer these birds frequent the coast. They run with great rapidity, and often for a considerable time mingle short flights and rapid runnings, till at length they avoid the danger pursuing them, by retreating to some cleft or hole, or flying off completely. It is observed to use various stratagems to attract attention from its young. The female builds no nest, and lays her eggs upon the ground.

C. morinellus, or the dotterel. This species abounds in various parts of England, particularly in Cambridgeshire. They are migratory, and appear often in flocks of eight or ten. They are supposed to breed in the mountains of Cumberland, as they appear there in May, and are not seen there after the breeding season. In June they become extremely fat in Lincolnshire and Derbyshire, and are highly esteemed for their flavour and delicacy. They abound in Sweden, Russia, and Siberia, and from their extraordinary stupidity fall an easy prey to the clumsiest stratagem of the fowler. See Plate IV. Aves, fig. 4 and 5.

CHARCOAL is wood burnt through, and suddenly extinguished by being covered with fresh earth. It is perhaps one of the most durable substances with which we are acquainted, not being decomposed either by the air or the water. It is of great use in many processes where a strong heat is required: it is an antiseptic; but very dangerous as fuel in confined places. In chemistry the terms carbon and charcoal were long confounded, and supposed to mean the same thing, but the experiments by

Morveau and others, have pointed out the precise distinction. See CARBON.

When charcoal is prepared in the usual way, by exposing wood in close vessels to a red heat, it always contains a portion of hydrogen. For if a quantity of this charcoal be exposed to a strong heat in a retort of porcelain, iron, or coated glass, a great quantity of gas is obtained. The gas which comes over first is a mixture of carbonic acid and heavy inflammable gas; but the proportion of carbonic acid diminishes, and at last it ceases to come over at all; yet the inflammable gas continues as copious as ever. The evolution of these gases was long ascribed by chemists to the water which charcoal usually contains, and which it is known to absorb from the atmosphere with considerable avidity. If that were the case, the proportion of inflammable gas ought to diminish at the same rate with the carbonic acid; the hydrogen of the one being equally derived from the decomposition of water with the oxygen of the other. But as the evolution of inflammable gas continues after that of carbonic acid has ceased, it is scarcely possible to deny, that the hydrogen which thus escapes constituted a component part of the charcoal.

If, therefore, we consider the experiments of Morveau on the combustion of the diamond as decisive, we must conclude, that common charcoal is composed of three ingredients, namely, carbon, hydrogen, and oxygen. It is of course a triple compound.

When common charcoal is exposed for an hour in a close crucible, to the stongest heat of a forge, it ceases to emit gas; and no temperature is sufficient to expel gas from charcoal thus treated. Desormes and Clement have endeavoured to demonstrate, that by this treatment common charcoal is deprived of the whole of its hydrogen. The same chemists tried the combustion of charcoal obtained from a variety of other substances exposed to the heat of a forge, as pitcoal, animal substances, and various vegetable substances, and found the products exactly the same. Hence they conclude that charcoal is in all cases the same, provided it be exposed to a heat strong enough; and they conclude too that by this strong heat the whole hydrogen of common charcoal is expelled.

These facts enable us to conclude, that there are two species of charcoal, namely, common and prepared charcoal. The first contains three ingredients, carbon, hydrogen, and oxygen; the second is deprived of a portion of its hydrogen and oxygen. It consists chiefly of carbon and oxygen united; but it still retains a small portion of hydrogen, and is not, therefore, strictly speaking, a pure oxide of carbon, though it approaches very nearly to such an oxide.

CHARGE, in gunnery, the quantity of gunpowder and ball wherewith a gun is loaded for execution. The rule for charging large pieces in war are, that the piece be first cleaned or scoured within side; that the proper quantity of powder be next driven in and rammed down: care however being taken, that the powder in ramming be not bruised, because that weakens its effect; that a little quantity of paper, hay, lint, or the like, be rammed over it; and that the ball or shot be intruded. If the ball be red-hot, a tampion, or trencher of green wood is to be driven in before it. The weight of the powder necessary for a charge is commonly in a subduple proportion to that of the ball.

CHARGE, in heraldry, is applied to the figures represented on the escutcheon, by which the bearers are distinguished from one another; and it is to be observed, that too many charges are not so honourable as fewer.

CHARGED, in heraldry, a shield carrying some impress or figure, is said to be charged therewith; so also when one bearing, or charge, has another figure added upon it, it is properly said to be charged.

CHART, or *hydrographical map*, in navigation, is a representation, in plano, of a part, or of the whole of the water on the surface of the globe, and the adjacent coast. There are various kinds of charts, as Globular, Plane, Mercator's, &c.

CHART, *globular*, is a projection so called from the conformity it bears to the globe itself. This projection was proposed by Senex, in which the meridians are inclined, the parallels equidistant and curvilinear, and the rhumb-lines real spirals, as on the surface of the globe. From this last property, it is evident it can be of very little use in navigation; as a map, however, it has its advantages.

Construction of Charts.

I. *Of the plane chart.*—The number of degrees of latitude which the chart is intended to contain, and the extent from east to west being fixed upon; a line is to be drawn near the side or end of a sheet of paper, in length equal to the whole length of the chart from north to south; and this line is to be divided into degrees

and numbered accordingly. From each end of this line perpendiculars are to be drawn, and made equal to the intended extent of the chart from east to west, and their extremities are to be joined by a straight line. If the chart is to commence at or near the equator, and to extend only a few degrees of latitude, the divisions of the parallels may be equal to those of the meridian: but if the chart begins at any considerable distance from the equator, it will conduce to accuracy, to make the length of each degree of the parallel equal to the co-sine of the mean latitude, the radius being 60 minutes; or the extreme parallels may be divided according to the above proportion, and in that case it will become a reduced chart. Meridians and parallels are there to be drawn at convenient distances.

A scale is now to be made of stiff paper or pasteboard, equal in length to the extent of the chart from east to west, and divided and numbered accordingly. By this scale, the positions of those places contained within the limits of the chart are very easily laid down, by placing the divided edge of the scale over the latitude of the given place; and under the given longitude, a mark being made will represent the position of the place on the chart.

A compass is to be inserted in any convenient place of the chart, an arrow shewing the direction of the flood tide or current. The times of high water at full and change are to be marked in their proper places, expressed in Roman characters; sounding and quality of the ground at bottom, the leading marks to avoid dangers, &c.

II. *Of a Mercator's chart.*—A Mercator's chart, for any given portion of the surface of the globe, is constructed as follows: the limit of the proposed chart is first to be determined, that is, the number of degrees of latitude and longitude which it is to contain, and the degree of latitude and longitude of its commencement. Find the meridional parts answering to each degree of latitude, within the intended limits of the chart, and take the difference between each, and that corresponding to the least degree of latitude in the chart; and reduce these differences to degrees, by dividing by 60.

A parallel, representing that of the least latitude, is to be drawn; upon which the number of degrees in the proposed difference of longitude, from a scale of equal parts, is to be laid off, and divided into degrees, and smaller portions of, if convenient, and numbered at each fifth or tenth degree. From each end of this parallel, a perpendicular is to be drawn, and made equal to the difference of the meridional parts of the extreme latitudes taken from the divided parallel; and the ends of these meridians are to be joined by a straight line, which will represent the other extreme parallel, and which is to be divided and numbered in the same manner as the first drawn parallel; the meridians are then to be divided into degrees, and numbered at every fifth or tenth degree. Take the meridional difference of latitude between the beginning of the chart, and the next fifth or tenth degree of latitude from the divided parallel, and lay it off from the first parallel on each of the scale meridians, and join these points by a straight line. In like manner the meridional difference of latitude answering to each successive interval of five or ten degrees, is to be taken from the first drawn parallel and laid off, and the corresponding parallels are to be drawn and numbered accordingly, and the intermediate spaces are to be subdivided. If the chart is upon a large scale, the meridional difference of latitude answering to each degree, is to be laid off from the least parallel.

If the chart is intended to be upon a larger scale, equi-multiples of the intervals are to be taken, such as will answer to the proposed extent of the chart. A slip of strong paper is to be divided, and numbered in the same manner as the first drawn parallel. Now each place within the limits of the chart is to be laid down, by placing the slip of paper, so that its extreme points of division may be at the latitude of the given place on each meridian; then, under the longitude of the place a mark is to be made, which will represent the position of that place. In like manner all the places on the coast are to be laid down, and connected by observations made on the coast; or if no sketch had been previously made, the contour of the coast is to be drawn agreeable to the best charts. Meridians and parallels are to be drawn through every fifth or tenth degree of latitude and longitude, and extended to the coast.

A compass is to be inserted in some convenient part of the chart, and the points extended to the land: an anchor is to be drawn where there is good anchoring ground, and in places where it is safe only to stop

a tide, an anchor without a stock is to be laid down. The soundings, the quality of the ground, the times of high water at full and change, &c. are to be marked in their proper places.

CHARTS, *manner of using.*—The principal use of a chart is, to find the course and distance between any two places within its limits, and to lay down the place of a ship on it, so that the position of the ship with respect to the intended port, the adjacent land, islands, &c. may be readily perceived.

To find the latitude of a place on the Chart.

Rule.—Take the nearest distance between the given place and the nearest parallel of latitude, which being applied the same way on the divided meridian, from the point of intersection of the parallel and meridian, will give the latitude of the proposed place.

Example.—Required the latitude of Port Louis, in the Isle of France. The least distance between Port Louis and the nearest parallel, being laid the same way on the meridian, from the extremity of that parallel, will reach to 20° 8′ S., the latitude required.

To find the course and distance between two given places on the Chart.

Rule.—Lay the edge of a scale over the given places, and take the nearest distance between the centre of any of the compasses on the chart and the edge of the scale; move this extent along, so as one point of the compass may touch the edge of the scale, and the straight line joining the points may be perpendicular thereto; then will the other point show the course; and the interval between the places being applied to the scale will give the required distance.

Example.—Required the course and distance from Cape St. André to Cape St. Sebastian, both in the island of Madagascar. The edge of a scale being laid over the two places, then, by moving the compass as directed, the course will be found to be N. E. ½ E., and the interval between them will measure 105 leagues.

The course and distance sailed from a known place being given, to find the ship's place on the Chart.

Rule.—Lay the edge of a scale over the place sailed from, parallel to the given course; then take the given distance from the scale on the chart, and lay it off from the given place by the edge of the scale, and it will give the point on the chart representing the place on the ship.

Example.—The correct course of a ship from Cape St. Maria, on the N. side of the entrance of the river La Plata, was N. E. by E., and the distance 238 leagues. Required the place of the ship on the chart. The edge of the scale being laid over Cape St. Maria, in a N. E. by E. direction, and the distance 238 leagues, laid off from Cape St. Maria by the edge of the scale, will give the place of the ship, which will be found to be in the latitude 28° 15′ S.

To find the longitude of a place on the Chart.

Rule.—Take the least distance between the given place and the nearest meridian, which being laid off on the equator, or divided parallel, from the point of intersection of the parallel and meridian, will give its longitude.

Example.—Required the longitude of Funchal in the island of Madeira. The least distance being taken between Funchal and the nearest meridian, and laid off from the intersection of that meridian with the divided parallel, will give 17° 6′ W., the longitude required.

To find the distance between two given places on the Chart.

1. When the given places are under the same meridian.

Rule.—Find the latitude of each; then, the difference or sum of their latitudes, according as they are on the same, or on opposite sides of the equator, will be the distance required.

Example.—Required the distance between the nearest extremities of the islands of Grenada and Guadaloupe.

Latitude of southernmost extremity of Guadaloupe	15° 52′ N.
Latitude of northernmost extremity of Grenada..........	12° 14′ N.
Distance..........................	3° 38′ = 218 M.

2. When the given places are under the same parallel.

Rule.—If that parallel is the equator, the difference, or sum of their longitudes, is the distance between them. If not, take half the interval between the given places, lay it off on the meridian on each side of the given parallel, and the intercepted degrees will be the distance between the

places. If the given parallel is near the north or south extremity of the chart, the following method may be used. Take an extent of a few degrees from that part of the meridian where the given parallel is the middle of the extent; then the number of extents, and parts of an extent, contained between the given places, being multiplied by the length of an extent, will give the required distance.

Example.—Required the distance between Cape Canton and Funchal, both lying nearly in the same parallel. By proceeding as directed above, the distance will be found to be 6° 44′, or 404 miles.

3. When the given places differ both in latitude and longitude.

Rule.—Find the difference of latitude between the given places, and take it from the equator or graduated parallel; then lay the edge of a scale over the given places, and move or slide one point of the compass along the edge of the scale, until the other point just touches a parallel. Now, the distance between the place where the point of the compass rested, and the point of intersection of the edge of the scale and parallel being applied to the equator, or divided parallel, will give the distance between the places in degrees and parts of a degree; which, multiplied by 60, will give the distance in miles.

Example.—Required the distance between Cape Finisterre and Porto Santo.

Take the difference of latitude between the given places, *viz.* 9° 54′, from the graduated parallel, and move one point of the compass along the edge of the scale, laid previously over these places, until the other point just touches a parallel: now, the interval between the place where the point of the compass rested, and the point of intersection of the scale and parallel, being applied to the divided parallel, will measure 11° 24′, or 684 miles.

CHARTA, *magna*, an ancient instrument, containing several privileges and liberties granted to the church and state by Edward the Confessor, together with others relating to the feudal laws of William the Conqueror, granted by Henry I. all confirmed by the succeeding princes. See MAGNA CHARTA.

CHARTER, in law, a written instrument or evidence of things acted between one person and another.

CHARTER-*party*, is a contract under hand and seal, executed by the freighter and the master or owner of the ship, containing the terms upon which the ship is hired to freight; the masters and owners usually bind themselves, the ship, tackle, and furniture, that the goods freighted shall be delivered (dangers of the sea excepted) well conditioned at the place of the discharge; and they also covenant to provide mariners, tackle, &c. and to equip the ship complete and adequate to the voyage. The freighter stipulates to pay the consideration-money for the freight, and penalties are annexed to enforce the reciprocal covenants. A charter-party is the same in the civil law as an indenture at common law; and is distinguished from a bill of lading, inasmuch as the former adjusts the term of the freight, and the latter ascertains the contents of the cargo.

CHARTERS *of community*, were certain privileges first obtained by violence or purchase, and afterwards freely bestowed by emperors, kings, and barons; whereby the inhabitants of towns and cities were enfranchised, all marks of servitude abolished, and these cities, &c. were formed into corporations and bodies politic, to be governed by a council and magistrates of their own nomination. The first person who conferred these privileges was Lewis the Gross in France, about the beginning of the twelfth century; and his example was soon very generally followed. These charters convey a very striking representation of the wretched condition of cities previous to the institution of communities, when they were subject to the judges appointed by the superior lords of whom they held, and had scarcely any other law but their will.

CHARTER *of the forest*, is that wherein the laws of the forest are comprised and established. In the time of King John, and that of his son, Henry III., the rigours of the feodal tenures and the forest laws were so warmly maintained, that they occasioned many insurrections of the barons or principal feudatories; which at last produced this effect, that first King John, and afterwards his son, consented to the two famous charters of English liberties, *Magna Carta*, and *Carta de Foresta*. The latter, in particular, was well calculated to redress many grievances and encroachments of the crown, in the exertion of forest law. This charter, as well as the other, was established, confirmed, and settled in the reign of Edward I.

CHARTER *governments in the British colonies*, are in the nature of civil corpora-

tions, with the power of making by-laws for their own interior regulation, not contrary to the laws of England; and with such rights and authorities as are specially given them in their several charters of incorporation. The form of government is borrowed from that of England. They have a governor named by the King, (or in some proprietary colonies by the proprietor) who is his representative or deputy. They have courts of justice of their own, from whose decision an appeal (as some say, in the nature of a reference by way of arbitration) lies to the King in council here in England. Their General Assemblies, which are their House of Commons, together with their Council of State, being their Upper House, with the concurrence of the King, or his representative, the Governor, make laws suited to their own emergencies. But it is particularly declared, by stat. 7 and 8 William III. c. 22. that all laws, by-laws, usages, and customs, which shall be in practice in any of the plantations, repugnant to any law made, or to be made, in this kingdom, relative to the said plantations, shall be utterly void and of none effect.

CHEAT, in law, is one who defrauds, or endeavours to defraud, another of his known right, by means of some artful device, contrary to the plain rules of common honesty. By the 30 Geo. II. all persons who knowingly or designedly, by false pretence or pretences, shall obtain from any person money, goods, wares, or merchandises, with intent to cheat or defraud any person of the same, or shall knowingly tend or deliver any letter or writing, with or without a name subscribed thereto, or signed with a fictitious name, threatening to accuse any person of a crime punishable by law with death, transportation, pillory, or other infamous punishment, with intent to extort from him any money, or other goods, shall be deemed offenders against law and the public peace; and the court before whom any such offender shall be tried, shall, on conviction, order him to be fined and imprisoned, or be put in the pillory, or publicly whipped, or to be transported for seven years.

CHECK, or CHECK *roll*, a roll or book, wherein is contained the names of such persons as are attendants and in pay to the King, or other great personages, as their household servants.

CHECKS, or *drafts on bankers*, are instruments by means of which a creditor may assign to a third person, not originally party to the contract, the legal as well as equitable interest in a debt raised by it, so as to vest in such an assignee a right of action against the original debtor. These instruments are uniformly made payable to bearer, which constitutes a characteristic difference between them and bills of exchange; and the legislature has considered them in a more favourable point of view, by exempting them from the stamp duties. They are equally negotiable with bills. When given in payment they are considered as cash; and, it is said, may be declared upon as a bill of exchange; and the moment this resemblance begins, they are governed by the same principles of law as bills of exchange. Checks payable on demand, or when no time of payment is expressed, are payable on presentment, without any indulgence or days of grace; but the presentment should be made within a reasonable time after the receipt, otherwise the party upon whom the check is drawn will not be responsible, and the person from whom the holder received it will be discharged. Therefore, where circumstances will allow of it, it is advisable for the holder of a check to present it on the same day it is received.

CHECKY, in heraldry, is when the shield, or a part thereof, as a bordure, &c. is chequered, or divided into chequers or squares, in the manner of a chess-board.

CHEEK, in anatomy, that part of the face situated below the eyes, on each side. See ANATOMY.

CHEEKS, among mechanics, are almost all those pieces of their machines and instruments that are double, and perfectly alike; as the cheeks of a mortar, which are made of strong wooden planks, of a semicircular form, bound with thick plates of iron, and fixed to the bed with four bolts: these cheeks rise on each side the mortar, and serve to keep it at what elevation is given it: the cheeks of a printing-press are its two principal pieces, placed perpendicular and parallel to each other, and serving to sustain the three sommers, &c.

CHEEKS, in ship-building, two pieces of timber, fitted on each tide of the mast, at the top, serving to strengthen the mast there, and having holes in them, called hounds, through which the ties run to hoist the yards.

CHEESE is made from the curd formed by mixing rennet with milk, the quality of

the cheese depending on that of the milk used on the occasion. Various processes are recommended, but to detail them would be a voluminous task; we shall, however, state, in as few words as the subject will admit, how cheese is usually made. The milk, being previously warmed, is turned, by the mixture of rennet, into an apparently solid mass. This being cut across with a brass knife, (for iron is supposed by many to give a bad flavour) occasions the curd to separate from the whey: the latter is given to pigs, or is sold as a beverage, while the former is put into a press made for the purpose, and all the whey is completely separated, falling through holes in the bottom of the press, while the curd is kept in by a coarse kind of cloth, made principally for that purpose. The curd must be repeatedly cut into minute squares, and be as often subjected to the press. When mixed for the last time, salt is added; and if any colour is to be given, a small quantity of annatto, or other colouring matter, is put in; though this is sometimes done in the early stages of the manufacture. Many put in sage-leaves, or mix plain and various-coloured curds together, according to fancy; the goodness of the cheese will, however, always depend on the richness of the milk. When the cheese has been kept a proper time in the mould, and will bear handling, it is taken out, and put on a shelf; carefully turning it every day, so that it may be dried alike; it is next rubbed with green nettles, &c. and by some with salt, under the opinion that these help to ripen it. Every county has some favourite recipe for the operation, and all alike claim the palm of pre-eminence: we may, perhaps, be correct in saying, that in each there are both excellent and execrable cheeses made. Cheshire, Gloucester, Wiltshire, and Stilton, seem to be the most approved, while, on the other hand, that made in Suffolk, being usually from skimmed or flitted milk, and, consequently, deprived of all the butyrous part, is considered proverbially poor.

As an article of diet, cheese cannot, on the whole, be accounted nourishing: that which is old, crumbling, and rich, is assuredly a powerful aid to digestion, and has been given with great success in cases where children have ate incautiously of crude fruits; but such as is dry, and of a sour taste, may be justly ranked among the minor poisons. The rennet which is used for turning the milk is nothing more than the stomach of a young calf, or of a pig, in which the gastric juices are preserved, by means of a handful or two of salt. A very small quantity of this preparation will suffice to many gallons of milk: and as the rennet-bag, as it is called, may be emptied, it may be once or twice replenished, though the liquor will not be so strong. Some dry the rennet-bag, after having been thus used, and throw a piece in to turn the milk. See Milk.

CHEIRANTHUS, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ Cruciformes. Essential character; germ with a glandulous toothlet on each side; calyx closed, with two leaflets, gibbous at the base; seeds flat. There are twenty-two species, of which C. cheiri, common wallflower, is about a foot high, with a woody stem; on walls it is seldom more than eight inches, with very tough roots and firm stalks; the leaves short and sharp-pointed; the flowers are well known, being one of those which have been cultivated for their fragrancy time immemorial in our gardens. C. incanus, stock gilliflower, is nearly the same height, shrubby, with spear-shaped leaves, which are frequently waved on their edges, and turn downward at the extremity; the side branches are each terminated by a loose spike of flowers, each having a woolly calyx, and four large roundish petals indented at the end. These usually appear in May and June. The flowers of this sort vary in their colour; some are pale and others of a deep red; the latter are generally most esteemed. If the seed be well chosen, frequently three parts in four of the plants will be double. C. annuus, annual stock gilliflower, or ten-week stock, is two feet high, with a round, smooth stalk, dividing into many branches at top. The flowers are produced in loose spikes at the ends of the branches, and are placed alternately; the calyx is large, erect, and slightly cut into several acute parts at the top; the petals are large and heart-shaped. Of this sort there are the red, purple, white, and striped; which are great ornaments in the borders of the flower-garden in autumn.

CHELIDONIUM, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rhoeadeæ. Essensential character: corolla four-petalled; calyx two-leaved; silique one-celled, linear. There are five species, of which

C. majus, common or great celandine, is from a foot to eighteen inches in height; cylindric, and a little hairy. The juice of the whole plant is saffron-coloured. It approaches to the class Tetradynamia in the cruciform shape of the corolla, and its silique, which, however, differs essentially in being one-celled. It is common in hedges, shady places, and uncultivated grounds, flowering from May to July.

CHELONE, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Bignoniæ, Jussieu. Essential character: calyx five-parted; rudiment of a fifth filament between the upper stamens; capsule two-celled. There are five species, of which C. glabra, white chelone, grows naturally in most parts of North America. It is about two feet high, with two leaves at each joint, standing opposite without foot-stalks. The flowers grow in a close spike at the end of the stalk; they are white, and have but one petal, which is tubular, and narrow at the bottom, something like the foxglove flower.

CHELSEA *hospital*, a noble edifice which was built by Charles II. on his restoration, and afterwards improved by his successor James II. Non-commissioned officers and private men, who have been wounded or maimed in the service, are entitled to the benefit of this hospital. There are in and out-pensioners belonging to the establishment, and the provisions of it extend to the militia under the following restrictions; serjeants who have served fifteen years, and corporals or drummers who have served twenty, may be recommended to the bounty. Serjeants on the establishment may likewise receive that allowance, with their pay in the militia. But serjeants who have been appointed subsequent to the passing of the 26th of George III. are not entitled to it under twenty years' service.

CHEMISTRY. All the changes that take place in bodies — whether by the operation of powers not under the direction of man, which are called natural phenomena; or of the same powers, modified in their direction by the exercise of our voluntary exertions, which constitute the processes of art—are effected by motion. When the bodies from their size and distance from each other can be separately distinguished by our senses, the effects are referred to the division of philosophical science called mechanics: but when the minuteness of the bodies themselves, and of the spaces to which the individual actions are confined, are such that we cannot view and contemplate them separately, but are under the necessity of inferring the nature and causes of their motions from general results or phenomena, the changes are referrable to chemistry.

Chemistry, therefore, as a science, teaches us to estimate and account for the changes produced in bodies by motions of their parts which are too minute to affect the senses individually: as an art, its practice consists in placing or applying bodies with regard to each other in such situations as are adapted to produce those changes.

In our investigation of the results of chemistry, we find ourselves, from the regular connection of the facts, enabled to foretel what will happen to certain bodies in certain circumstances; and the rules by which, from experience, we are capable of doing so, are called laws of nature, if they relate to bodies in general; but when they relate to particular descriptions of bodies, we form our expressions so as to refer the effects to the bodies themselves under the name of qualities or properties. The discovery of these laws and properties must in the first instances be effected from the observation of natural events, and afterwards by instituting experiments for the express purpose of manifesting them. In these experiments we may either separate compounded bodies into their simpler parts, which is called analysis: or we may unite simple parts so as to form a compound body, which is called synthesis. And our reasonings concerning these facts will have a correspondent denomination. When we describe and explain the process of analysis, by which general results are deduced by separating effects from each other, the operation of the mind is distinguished by the same name; but when from the general results we show in what manner particular events are produced by combining bodies together, the method is distinguished by the term synthesis.

The synthetical method of teaching is undoubtedly the most luminous and clear where the first principles or simple elements of our knowledge are known or admitted, as is the case in geometry. But in chemistry this method of teaching cannot, from our imperfect knowledge of the facts, be generally adopted, without admitting the simplicity of a variety of substances concerning which there is just reason to doubt.

It is true, indeed, that such admissions are generally made with a previous notice or reservation of this uncertainty. But by the constant use of the supposed facts, along with others which are better established, the mind becomes habituated to mix hypothesis with facts; and the imaginary beauty of connected science must from time to time be destroyed by the appearance of new truths. The revolutions of chemical science have amply shown this; and the numerous imperfections which still remain have left considerable latitude for the arrangement of materials in a system of chemistry. If the theory were in its commencement, a treatise on chemistry would be little more than a collection of receipts for processes; and even in the present state of the science, different authors of credit and respectability greatly differ in the disposal of their subjects. Operative chemistry usually precedes the theory in the earlier works. Some writers treat of compound bodies, and deduce their principles or component parts in the way of analysis; while others begin with the habitudes or powers by which the several changes are effected. But it must be confessed, notwithstanding the magnitude of the discoveries which have been really made, and the elevated pretensions of a few theorists, that the practical science is still in its infancy. Every one of the phenomena is sufficiently complicated as to be referable to various topics of consideration; and to which of these in a general way our attention shall be first directed, is in many cases a matter of indifference. It appears to us that the advantages of treating the subjects in a popular way, by first attending to the general properties and habitudes of bodies, and the methods of operating upon them, and from thence proceeding to the different classes of bodies, are such as entitle this method to a preference before other arrangements which afford a greater appearance of synthetical order.

When we have simplified our notions of the causes of change which happen to bodies under the distinction or division of chemistry, we must resolve them into two, namely, heat and attraction. Daily experience shews us that bodies may be more or less heated, and also that they adhere to each other. We are in truth unable to proceed farther in our abstractions. The causes of those well known effects have not yet been developed by the manifestation of any more simple facts upon which they may depend. We can only observe the laws according to which these powers have been found to act, and make our classification of the phenomena; and as it is of some utility, in directing our future researches, to make conjectures by analogy, it may also be permitted to speculate upon the causes of these primary effects, provided it be done with caution, and without that bigotry which even in systems of philosophy has so frequently established the results of error.

Besides the effects of heat and attraction, we find that bodies are changed and modified by light, electricity, galvanism, and magnetism, the three last of which are accompanied by attraction or repulsion. But as these are much less generally applicable in operative chemistry than the powers first mentioned, and as it seems likely that future discoveries may lead to some intimate relation, or perhaps show the identity of the cause of heat, light, and the other affections of matter which have here engaged our attention, it is unnecessary to enlarge upon these in the present article.

The word attraction denotes the unexplained tendency which bodies have to move to each other. We observe it acting at a distance in the fall of bodies on the surface of the earth, and in the motions of the heavenly bodies, as well as in such as are affected by electricity, galvanism, or magnetism: and in the cohesion which gives solidity, or, more properly, rigidity to bodies, as well as in those effects wherein the parts of different bodies unite to form new compounds, we deduce its effects from motions or actions which cannot be separately distinguished. And these differences, though they cannot be shown to arise from one and the same power, or from energies originally dissimilar, require at least for the purposes of language to be treated apart from each other. Chemistry seems to have little to do with the perceptible attractions: it is principally confined to the state of bodies, as it relates to the cohesion and the combination of their parts.

Heat, or rather temperature, is a well known modification of bodies, by which they produce a peculiar sensation distinguished by the same word. Its laws have been very successfully investigated by our contemporaries; for which see Caloric, Heat, and Combustion. The operative chemist considers it as the means of converting solid bodies into dense fluids, and dense fluids into elastic fluids called gas or vapour, while compound bodies may

have their parts separated from each other by this treatment.

When bodies of different kinds are brought into contact, they produce very little of the change called chemical, while they continue in the solid state. Mechanical trituration will forward their mutual action by multiplying the surfaces of contact; but still the masses continue too large to be moved amongst each other by the peculiar attractions they may be capable of exerting. It has been considered as an axiom in chemistry that bodies do not act on each other unless one or both be in the fluid state; and though this is not strictly and universally true, yet it is requisite for almost every operation of chemistry that this condition, either of dense or of elastic fluidity, should obtain. The facility with which the parts of fluids move amongst each other, is no doubt the principal cause of this increased effect.

The practical part of chemistry may be therefore said to consist almost entirely in separating or changing the order of the parts of bodies by heat, or of placing bodies in such situations with regard to each other as that, with the assistance of heat, if needful, to produce fluidity, changes or separations of the same kind may take place among their parts. The actions of electricity, galvanism, and light, will probably be soon combined among the leading resources of chemistry.

No change could take place by this or any other treatment, if the attractions of the parts of bodies to each other were all perfectly the same. It is manifest from the facts, that the attraction between some bodies is stronger than between others, and from this remarkable variety in the habitudes of bodies, the attractions of chemistry have been called elective attractions.

A distinction has been made between those processes in which water is present, and those in which the requisite fluidity is produced by strong heat. The first method is called the humid way, and the other the dry way.

The practice of chemistry requires in most cases of solid bodies, previous to the application of heat, or of one body to another, for the exercise of the attractions, that some mechanical means should be taken to divide their parts from each other. These are, 1, chopping or cutting; 2, rasping, filing, or shaving; 3, pulverizing or grinding; 4, granulation, as when shot is formed by pouring lead into water, or a powder of the metal is obtained by shaking it in a box, in the fused state, till it congeals; 5, elutriation, or washing, to separate the finer or lighter parts of bodies from the coarser or larger, as when earthy matters are washed from the heavier metallic ones, or when a fine powder, such as that of pounded emery, is suspended by agitation in water which is decanted off, and then set to subside while the coarser particles, which settle immediately, are left behind; 6, hammering, or forging, as in the making of tin foil, or leaf gold, or in the extension of other metals whether hot or cold; 7, laminating, as when the metals are passed between steel rollers, or when wax is poured upon a wooden cylinder, turned round in cold water; and, 8, wire drawing, as when the metals are drawn through an hole in a plate to make wire, or forced through an engine, such as that employed for glazier's lead, &c.

Bodies are distinguished, with regard to heat, into fixed, volatile, and refractory. The first can scarcely, if at all, be evaporated; the second are easily raised or driven off; and the third undergo no change.

The simple application of heat is distinguished by various terms, according to the nature of the operation, or of the effects produced. These are, 1, roasting, which consists in exposing minerals to an open fire, to drive off their volatile contents; 2, calcination is the exposure of a body to strong heat, in an open vessel, till it undergoes no farther change. This word, which was formerly used in a general way, is now confined to earths and some of the salts, and is indeed seldom used; 3, oxydation is the like process with metallic bodies; 4, fusion or melting, is the production of the state of dense fluidity; 5, cementation is a process wherein solid bodies of different kinds, one or more of them being in powder, are exposed to heat in a vessel nearly closed, with the intention that the more volatile parts of the one may unite with the other, or its fixed parts; 6, eliquation is the exposure of a compound body, usually metallic, to heat, sufficient to fuse one of its ingredients, which runs out and leaves the other solid and porous; 7, digestion consists in keeping bodies for a considerable time immersed in a fluid more or less heated, in order to effect some combination between them; 8, evaporation is the dissipation of a fluid by heat; 9, concentration consists in diminishing the proportion of water in any solution of saline

matter, either by heating it, or by freezing the surplus water and taking out the ice; 10, when evaporation is performed in any apparatus of vessels, partly or quite closed, and the vapours, after being raised by heat in one part or vessel, are received in another sufficiently cold to condense them into the fluid slate, this process is called distillation; 11, when a fluid obtained by distillation is again distilled, in order to obtain the most volatile part of the first product, this last part is said to be rectified, and the process is called rectification. This term has become nearly obsolete in scientific description, but is still retained in the Arts; 12, there are many products of evaporation which congeal, or become solid at a temperature much higher than that of the atmosphere, and are not, therefore, obtained in the fluid, but the solid state. These usually adhere in the form of crystals to the upper part of the apparatus; and on this account, as well as because the operation does not in general require the same kind of vessel, it is distinguished by the name of sublimation, and the products themselves are called sublimates, and in some instances flowers; but these two last terms are more particularly confined to the Arts. Other terms are also used, such as fusible, evaporable, &c. but their sense is manifest.

For the apparatus used in these and the other operations of chemistry, see LABORATORY.

The consideration of what happens to the parts of bodies, in consequence of their elective attractions, constitutes the most difficult part of the science, whether the mind be employed in developing the facts, or in deducing the general theory which may be indicated from them. It is, therefore, necessary to consider them with some attention, and in a regular manner.

The adhesion of parts, considered to be of the same kind, is called aggregation. Thus a number of pieces of glass melted together form an aggregate; and the smallest parts into which an aggregate can be imagined to be divided, so as not to change its nature, are called integrant parts; so that the integrant parts of glass are themselves glass. But when the body is known to be made up of parts of different kinds or nature, and it is considered with regard to these, the body is called a compound, or combination, and the parts are called component parts, or principles. In this manner glass is a compound of the earth called silex, and a salt called alkali, combined together at a strong heat: and we may imagine that if there were any means by which glass could be reduced, first to its integrant parts, and the division could be carried farther, the parts would then be no longer integrant and glass, but would become divided into component parts, namely, earth and alkali. Bodies are also considered in a wide manner by the name of mixtures, when small aggregates of different kinds are united, as in a variety of minerals where the parts are frequently distinguishable by the senses: and in the arts we have sand and lime made into mortar by mixture, or sand, clay, and other earths, made into pottery, and hardened by a moderate fire; but these by a stronger heat may be made to combine into glass, and are then no longer mixtures, but compounds.

The early chemists were led into a supposition, that the bodies they were unable to analyze were simple, and they distinguished them by the name of elements. It is probable that the great variety of bodies around us are formed, by combination, out of a few simple principles, or perhaps out of one single element, variously combined as to figure and position of parts; but it is useless and unprofitable to speculate on probabilities, which experiment can never verify. Modern chemists, very properly, consider those bodies as simple which have not yet been decomposed; but this is merely with relation to the present state of our knowledge, and for the sake of arrangement and induction. They do not lose sight of the necessity of instituting experiments for their farther analysis; and the great discoveries which have done honour to our own times are a proof of their diligence and sagacity.

We do not know of any means of ascertaining by experiment, whether compound bodies do enter as principles into other bodies still more compounded; or whether in bodies of three or more principles, all the simple particles do dispose themselves without any dependance on the order of time, according to which they may have been put together. It is probable that the former is the case, so that we may hereafter be enabled to designate primary principles, or bodies not yet decomposed; secondary principles, or bodies of two primary principles, which nevertheless can enter into combination, or be disengaged without separation from each other; ter-

nary principles, &c. In this manner sulphur, by combining with oxygen and water, will form sulphuric acid, and this acid may be combined with a metal, so as to form a salt capable of giving out its acid again by heat. Our systematic books are written according to the supposition of secondary and more complicated principles; but the facts do not indisputably prove their existence.

When two bodies in the solid state which are disposed to combine are brought into contact, the combination will begin at the place where they touch, and if the compound be of such a nature, as that its freezing point (see CALORIC) is lower than the common temperature of the bodies, it will be fluid, and the combination may proceed to the other parts of each till the whole shall have united. Thus snow and salt will form a fluid brine, if the temperature be higher than 6° below the commencement of Fahrenheit's scale.

If a solid be united with and suspended in a fluid, the former is said to be dissolved or in solution, and the fluid is called a solvent. In this manner water dissolves sugar or salt. Fluids in general dissolve greater quantities the higher the temperature, probably from the fluid state being promoted by heat.

Some substances unite in all proportions, such as most acids in water; but others have a limit; as for example, water will dissolve only one fourth of its weight of common salt. It is then said to be saturated. But chemists use the word saturation in another sense. When two principles, as for instance, an acid and an alkali, are combined, the properties of each disappear when a due proportion of each is present; but if either of the principles exceed that proportion, the predominating property will be that of the principle which is in excess. In these cases the principles are said to be saturated when the properties are most completely balanced; but in the other cases the principle which is defective in quantity is said to be super-saturated, or over saturated, and the other principle which is in excess is said to be under saturated: acids united with alkalies manifest these cases very strikingly.

In the consideration of the phenomena of chemical or elective attraction between the principles of bodies, it will be very difficult to select instances for illustration, which shall be simple either as to the principles or the effects, because in almost every case there is a degree of complexity which obtains in nature, and even where we suppose a great simplicity of principles, they may hereafter be discovered to be compound. But the doctrine will be understood, and fixed in the memory by the examples to be brought; in the same manner as when diagrams are used by geometricians, though the actual figures cannot strictly agree with their hypotheses or postulates.

1. The mutual action of two bodies exhibits the phenomena of simple elective attraction and rejection: when two principles are presented to each other, they may either combine or reject each other. Thus water combines with and dissolves gum, but rejects camphor: and alcohol combines with and dissolves camphor, but rejects gum.

It is probable that all simple bodies, if insulated, would combine together, and that the phenomenon of rejection, when it takes place, is an effect of some of the compound elective attractions, upon which we shall presently speak.

When a body is suspended to saturation in a solvent, no more can be taken up or supported, because the cohesive attraction, or that of the parts of the body to each other, is stronger than that of the fluid to the same, and it is found that the power of the solvent is greater the less it is charged, until it ceases at the point of saturation. Elasticity, or the energy by which bodies are converted into gas or vapour, is likewise an opponent to solution or combination, and gives a point of saturation which may be varied by preventing or impeding the assumption of the elastic state.

2. When three bodies or principles are presented to each other in succession, we may conceive a variety of results, all which appear to take place in nature. Thus (*a*) they may not perceptibly unite, or (*b*) two may unite, and the third have no action either upon them singly or when in their combination; or (*c*) all three may unite from attractions exerted between each singly upon the others, and form a triple compound; or (*d*) two of them may have no attraction for each other, but being both capable of combining with a third, this last may be the instrument of union between the two, and a triple compound will be thus formed. In this case the effect is said to be performed by intermediate attraction, and the attracting body is called

a medium. Thus oil and water will not unite, but either of them will unite with an alkali; and if this last be united with oil, it forms soap, which can be united with water. The alkali is the medium; or (*e*) two principles which attract each other may neither of them be capable of direct or ready union with a third; but when the two former shall be actually combined together, the compound shall attract and combine with the third body and form a triple compound. This new power is called resulting attraction. Thus neither sulphur nor potash have any sensible action upon gold; but when they are fused together they combine with that metal. Most of the effects of resulting attraction are consequences of the change of state of bodies, particularly to that of fluidity; and the effects of this attraction and that by a medium often exist in the same case; or, (*f*) if we suppose three principles to be in such circumstances of aggregation or temperature as to have no perceptible disposition to unite in pairs, but that the resulting attraction of a compound of two of them, if united, would then act upon the third, and produce a triple combination, it may happen that this resulting attraction, which seems to be only in prospect, shall have power to complete the triple compound; and the modification is called disposing attraction. Thus vinegar has no perceptible action upon copper, but it can dissolve the compound of copper and oxygen, called the oxide of copper: neither vinegar nor copper have any disposition to take oxygen from its elastic state in the atmosphere, so that copper and vinegar may be kept together without solution in a closed vessel: but if the air be admitted, the presence of the vinegar will dispose the copper to take oxygen and form an oxide, and with this combination the vinegar will unite. There is much convenience in the term, disposing attraction, as used to express this phenomenon, though it must be confessed that this prospective disposition, ascribed to unconscious beings, seems to produce some confusion in the mind. It may therefore be proper to notice that the case seems to belong to disposing attraction, and may be thus hypothetically explained. Copper, and several other metals which attract oxygen from the air, become covered with a thin oxide or rust, which prevents any farther access of that fluid, and consequently it rusts no farther, unless the thin coat of oxide be scraped off and a new surface exposed, and if this were continued to be done, all the copper would be gradually oxided. Now the vinegar, by the condition of our case, does this, and the copper is gradually and totally dissolved; not, as it appears, because the copper and oxygen are disposed to unite by a third power, which, as it were, waits for them, but because this power removes an impediment which would impede their progressive union.

(*g*) The case of attraction, which has most particularly engaged the attention of chemistry, is that where two principles being combined are separated from each other by the addition of a third, which combines with one of them. This has, perhaps improperly, been called simple elective attraction, and by others precipitating attraction: its principal effects or distinguishing character would, it seems, be better designated by the terms decomposing attraction. Thus, if sulphuric acid and magnesia be combined in the salt called sulphate of magnesia (dissolved in water) and potash be added, the acid will unite with this last, and the magnesia will be separated and fall down. It was for a long time thought that these combinations and separations were complete and entire; but they appear in every instance to form cases of the intermediate or resulting attractions, wherein the proportions of the soluble and insoluble parts are extremely different, and the degrees of saturation often modify the results. For the body separated has always a small proportion of the two others, and the new compound usually suspended is not binary, but triple at least; and the proportions and effects are more or less altered by the quantity of solvent present, and the aptitude of the new combinations to take the solid, fluid, or elastic states.

Tables of separation or decomposition have been called tables of simple elective attraction. They are usually drawn up to express effects in the humid way with moderate proportions of water at the middle atmospheric temperature; and in the dry way by the operation of fire acting upon the containing vessels to raise their temperature. From the reasons just mentioned, they cannot be admitted as denoting invariable effects, but they are nevertheless useful, provided the modifications of circumstances be attended to in our general reasoning. See Elective Attraction.

3. In our present discussion it was not practicable, from the nature of the subject,

to avoid presenting facts for illustration, in which more than three principles were concerned; though the doctrines to be elucidated supposed no more than that number to be present. This supposition can admit only of one combination, either of two or of three principles; but in the complex effects of chemical attraction, four or more bodies may be treated of as forming distinct and separate combinations; and these compounds being presented to each other, may be affected by all the habitudes and circumstances upon which we have so long dwelled, besides such others as arise from their greater complexity. These cannot be here fully treated. It will be sufficient at present to overlook those effects wherein compounds of many principles may be formed, or in which the intermediate, or resulting, or disposing attractions may operate, and regard only the cases in which two binary compounds, being presented to each other, do either remain unaltered, or else exchange their principles so as to form two other binary compounds. A few years ago this was thought to comprehend the greatest part of the doctrine of chemical attractions; but as practical science advances the supposed simplicity of the facts becomes less than before.

These phenomena, afforded by two binary compounds, have been classed under the denomination of effects of double elective attraction. These facts may be considered with regard to the whole force of the attractions that tend to retain the original compounds, which have been called quiescent attractions, and the whole force of the attractions that tend to produce two new binary compounds, which have been called divellent attractions. If the former be the greatest, the change will not take place; but if the latter exceed, it will. Thus, if to the sulphate of potash lime be presented, the sulphuric acid being more strongly attracted by potash than by lime, no decomposition will ensue: but if muriate of lime be presented to the sulphate of potash, the lime will not only attract the sulphuric acid, but the muriatic acid will attract the potash; and the sum of the divellent attractions, namely, of the lime to the sulphuric acid, of the muriatic acid to the potash, being greater than the sum of the original or quiescent attractions; namely, of the sulphuric acid to the potash, and of the muriatic acid to the lime, two new compounds, namely, sulphate of lime and muriate of potash, will be formed. See ELECTIVE ATTRACTION.

The most essential difference between the complicated cases of attraction here described, and those treated of just before, is, that the principles in these last are either saturated, or nearly so, when presented to each other; and from this difference, and the number of principles, it is that the effect of solvents, the force of cohesion and of elasticity, as well as of temperature, and other circumstances, act with more effect than in the simpler cases.

Whenever the cohesive attraction operates so as to form solid aggregates, whether by the congelation of fused bodies by cooling, or the deposition of bodies from their solvents, the aggregates, if not disturbed by too rapid condensation, or by other causes, have the form of solids bounded by flat surfaces, meeting each other in certain definite angles. These solids are called crystals. The property of crystallizing seems to be a natural consequence of the resulting attractions. For if a binary compound be attracted by any other principle or compound, and the time and circumstances allow the particles to turn round, it appears obvious that the appulse and adhesion will be made by such sides of the bodies as are occupied by particles most strongly attractive of each other; and this regularity of apposition must produce regularity of figure. See CRYSTALLIZATION.

After this general statement of the means and agents of chemistry, it remains only for us in this general article to give an outline of the different substances or principles upon which the processes of nature and art are performed, and upon which the articles devoted to each may be consulted.

CHEMICAL ARRANGEMENT OF BODIES.

I. *Substances not yet decomposed, called simple principles.*

1. Principles of doubtful existence. These are (*a*) heat, (*b*) light, and the causes of (*c*) galvanic, (*d*) electric, and (*e*) magnetic phenomena. These energies cannot be confined in vessels; they are not measurable by figured extension or by gravity; we know nothing of their compounds; and they accompany and are excitable in other bodies by manipulation: from which, and other reasons, they have been thought to be modes, properties, or occasional habitudes of bodies. But, on the other hand, they possess so many distinctive characters, that a large class of philosophers ascribe them to certain peculiar fluids, or to one common fluid. See ETHER.

2. Simple principles, which have been exhibited only in the gaseous form, unless in combination. These are (*a*) oxygen, (*b*) hydrogen, (*c*) azote, or nitrogen. The character here assumed for classification might seem insufficient, as being merely relative to our present means of attempting to condense these bodies, if there were not some strong distinctive circumstances belonging to them. In particular, oxygen with hydrogen forms water, of which an immense ocean covers two-thirds of the surface of our planet; and oxygen with nitrogen forms the air of that atmosphere which surrounds us on all sides to the height of many miles, and would, if it could be compressed to the density of common earth, cover all the land and sea to the depth of at least fifteen feet: and (*d*) the unknown base of muriatic acid ought probably to be admitted in this place.

3. Simple principles, not combustible. These are (*a*) earths, distinguished by a want of fusibility, volatility, and solubility in water, which in most species is almost total. There are nine at present known; namely, silex, alumina, lime, magnesia, barytes, strontites, zircon, ittria, glucine; and (*b*) alkalies, which are fusible, volatile by a red heat, and very soluble in water; three are known; potash, soda, and ammonia.

The recent decomposition of the two former alkalies (see ALKALI), and the well known composition of the latter, must with propriety exclude them from their present situation; but they are retained in this class of incombustibles until the confirmation and developement of those facts shall have perfectly settled their place.

4. Simple principles, combustible, and in some aggregations transparent. These are, (*a*) diamond, or carbon; (*b*) sulphur; and (*c*) phosphorus. The two latter of these combine readily, and burn with the oxygen of the atmosphere; the latter, in various of its compounds and species, appears to be impeded in its combustion by the force of cohesion in the aggregate.

5. Simple principles, combustible, opaque in every state of solid aggregation, and peculiarly brilliant by reflection; metals. Of these, 28 are at present known. 1. Gold; 2. Platina; 3. Silver; 4. Mercury; 5. Iridium; 6. Osmium; 7. Rhodium; 8. Palladium; 9. Copper; 10. Iron; 11. Lead; 12. Tin; 13. Zinc; 14. Bismuth; 15. Antimony; 16. Nickel; 17. Cobalt; 18. Manganese; 19. Arsenic; 20. Tellurium; 21. Chrome; 22. Molybdena; 23. Tungsten; 24. Titanium; 25. Uranium; 26. Columbium; 27. Tantalium; 28. Cerium.

II. *Primary compounds, or combinations of two simple principles.*

1. Water; composed of oxygen and hydrogen.

2. Ammonia; composed of hydrogen and azote. And in this place we may expect hereafter to place the other alkalies and the earths.

3. Oxides; composed of combustible principles, particularly metals, combined with oxygen. These are, (*a*) oxides of carbon; as plumbago, common charcoal, carbonic oxide of azote,—of sulphur,—of phosphorus; and (*b*) of the metals.

4. Acids; combustibles, or metals combined with a larger portion of oxygen than exists in their oxides. The oxygenated substance is called the base of the acid, and there are acids with two, and perhaps more, bases. Rejecting, for the present, their modifications arising from more or less of oxygen, they are the sulphuric, nitric, muriatic, phosphoric, carbonic, fluoric, boracic, arsenic, molybdic, chromic, tungstic, columbic, acetic, benzoic, moroxylic, camphoric, oxalic, mellitic, tartaric, citric, sebacic, saclactic, laccic, malic, suberic, formic, prussic, gallic.

5. Compounds of two incombustible principles. These are either earths with earths, as in (*a*) pottery, which for the most part is a mixture of aggregates;—or earths with alkalies, which form (*b*) glass.

6. Compounds of a combustible and an incombustible principle. (*a*) Sulphurets of lime, magnesia, barytes, strontites, potash, soda, ammonia; (*b*) carburet of alumina; and (*c*) phosphurets of lime; barytes; strontites.

7. Compounds of two combustible principles. (*a*) Hydrogen with carbon; carburetted hydrogen gas; supercarburetted hydrogen gas, or olefiant gas. (*b*) Hydrogen with metals; gasiform suspension of arsenic, zinc, or iron. (*c*) Carbon with sulphur; carburet of sulphur. (*d*) Carbon with iron; carburet of iron, or crude iron. (*e*) Sulphur with hydrogen; sulphuretted hydrogen gas. (*f*) Sulphur with phosphorus; sulphuret of phosphorus. (*g*) Sulphur with most of the metals; sulphurets of each. (*h*) Phosphorus with hydrogen; phosphorized hydrogen gas, phosphuretted hydrogen gas. (*i*) Phosphurets of carbon. (*k*) Phosphurets of many of the metals. (*l*) Metals with metals; alloys.

III. *Secondary compounds, or compounds of more than two simple principles.*

Though it cannot yet be determined whether the binary, and other compounds, enumerated in the last section, may exist as distinct principles in the combinations into which they may enter, it is nevertheless certain, that, either from this cause, or from the general predominance of the attractions to which they owe their formation, the appearances in composition and decomposition are such as admit of the affirmative supposition in by far the greater number of cases. This was taken for granted by the earlier chemists, and habit and convenience has continued their language to the present time.

The binary compounds, taken in the preceding order, will indicate the following secondary combinations.

1. Water combines with a great number of bodies, and in general may be separated by evaporation, congelation, or the effect of elective attraction, without any change in its own composition. It has been accordingly considered for a long time as a simple element, and is even now very often disregarded in its agency upon substances which it may hold in solution. (*a*) It absorbs very small portions of oxygen, hydrogen, or azote, and emits them upon raising the temperature, or lowering it to congelation. No proof has been given of its being capable of uniting in perfect combination with either of its component parts beyond the point of saturation. (*b*) It dissolves barytes plentifully, and strontites and lime sparingly; and it very actively takes up large proportions of the alkalies; but from all these it may be separated without alteration by mere heat. (*c*) Its action upon carbon, sulphur, phosphorus, or the metals, is not sufficient to produce any sensible combination or decomposition, unless at a very elevated temperature, such as that of ignition. (*d*) The oxides are scarcely affected by it; perhaps only when they approach the state of acidity. (*e*) Many of the acids unite strongly, and in all proportions, with it, and they are all more or less soluble. (*f*) The sulphurets and phosphorets are suspended, and decomposition of the water takes place by disposing double affinity; part of the sulphur taking oxygen from the water, and forming acid, which combines with the earth or alkali; and another part of the combustible uniting with the hydrogen of the decomposed water, and forming hydrosulphuret, part of which remains in solution, and part rises in form of gas. (*g*) The compounds of two or more combustibles are not sensibly acted upon by water.

2. The alkalies combine (*a*) with all the acids, and form compounds called neutral salts, more or less soluble in water; and also (*b*) with several of the earths and (*c*) of the metallic oxides; forming combinations, which, from the little attention yet paid to them, have received no particular denominations.

3. The earths also unite (*a*) with the acids, and form salts similar to those called neutral, and also for the most part soluble in water. Some of these likewise unite (*b*) with each other, and (*c*) with metallic oxides, by compound attraction during precipitation in the humid way.

4. Acids are the most powerful agents of combination with alkalies, earths, and metallic oxides, in the humid way, with which, as has been observed, they form salts. The earth silex is not taken up in any perceptible quantity by any acid but the fluoric, and this suspends it even in the form of gas.

5. The compound of hydrogen and sulphur acts in the manner of an acid upon the alkalies, earths, and metallic oxides. For which, and the effect of acids on the compound combustibles, reference must be made to the respective articles.

It would carry us too far into the business of arrangement in this place, if we were not to adopt the same proceeding of referring to the parts and products of VEGETABLE and ANIMAL *bodies;* we shall therefore only mention five classes of the products of organized substances, which, from their exclusive application to chemical operations, cannot be passed without notice. These in the last results afford carbon and hydrogen, or carbon, hydrogen, and oxygen. They are, (*a*) alcohol, or spirit, ardent; (*b*) ether; (*c*) oils, volatile; (*d*) oils, fixed; (*e*) bitumens.

CHENOLEA, in botany, a genus of the Pentandria Monogynia class and order: natural order of Holoraceæ; Atriplices, Jussieu. Essential character: calyx globular, one-leafed, five-parted; capsule one-celled, containing one smooth seed, bifid at the tip. There is but one species, *viz.* C. diffusa, which is a native of the Cape of Good Hope.

CHENOPODIUM, in botany, English *goose-foot,* a genus of the Pentandria Digynia class and order: natural order of Holoraceæ: Atriplices, Jussieu. Essential character, calyx five-leaved, five-cornered; corolla none; seed one, centicular, superior. There are twenty-three species.

CHERLERIA, in botany, so called in honour of Cherler, assistant and son-in-law to John Bauhin: a genus of the Decandria Trigynia class and order: natural order of Caryophyllei. Essential character: calyx five-leaved; nectaries five, bifid, resembling petals; anthers alternate, barren; capsule one-celled, three-valved, three-seeded. There is but one species, *viz.* C. sedodides; stone crop cherleria. It is found on the mountains of Dauphine, Switzerland, Savoy, the Valais, Austria, Carniola, and the Highlands of Scotland. Perennial; flowering in August.

CHERMES, in natural history, a genus of insects of the order Hemiptera. Generic character; snout placed in the breast, with three inflected bristles; antennæ filiform, pubescent longer than the thorax; four wings deflected; thorax gibbous; hind legs formed for leaping. There are 24 species. They inhabit various trees and plants, and produce, by their punctures, protuberances and excrescences of various shapes and sizes, in which are frequently enclosed the eggs and insects in their several states: the larva is six-footed and apterous: the pupa is distingushed by two protuberances on the thorax, which are the rudiments of future wings. C. alni is found on the leaves and shoots of alder; its larva is entirely covered about the hinder part by viscid down or cotton; this, if purposely rubbed off, is quickly reproduced by the animal, which secretes the white fibres from large pores placed in a circle at some distance from the vent. These larva are gregarious, often appearing in such numbers on the shoots of the tree that the whole shoot appears covered with cotton, which, if touched with the finger, separates into distinct tufts, from the animals being suddenly disturbed, and moving in all directions. C. buxi; antennæ setaceous; wings yellowish brown. Its punctures make the leaves bend in towards each other at their extremity, forming a hollow knob in which the larva are enclosed.

CHERRY *tree*, in botany. See PRUNUS.

CHESNUT *tree*. See FAGUS.

Next to the oak the chesnut timber is most coveted by carpenters and joiners. It likewise makes the best stakes, pallisadoes, vine props, hop-poles, &c. and is also proper for mill timber and water-works. It is likewise fit for chests, tables, bedsteads, columns, &c.

CHESS, a game played by two persons sitting *vis-a-vis*, and having between them a square board, containing 64 rectangular chequers, alternate white and black: each player has the white corner square at his right hand. The pieces are as follows, for each party. A queen, which is always placed on her own colour: thus, the white queen is on a white square, the fourth from the corner, and the black queen on the black square facing the white queen. Their respective kings are then placed by the sides of the queens, so that each couple occupy the two centre squares on the lines nearest the players. Two bishops are then placed, one on the side of the king, the other on the side of the queen, on squares of different colours. Bishops are generally distinguished by a kind of mitre on their tops: at the sides of the bishops are placed the two knights, also on different coloured squares: these are usually distinguished by horses' heads, or by having a piece obliquely taken off from their flat round bonnets. The exterior pieces are called castles or rooks, and are commonly made to resemble turrets; or may be only pawns of a larger size. The pawns, eight in number, are ranged so as to occupy all the squares on the second line, immediately in front of the line of pieces. Pawns are generally pieces of turned wood, of a neat pattern, and with spherical summits. This description of one party will answer for both: observing that the players are designated according to the colour of their pieces. Such as are white or yellow, are called white, and such as are black, red, green, &c. are called black.

The king can only move one square at a time, but in any direction that may be open to him: he cannot, however, move to, nor remain on, a square which is commanded by any of the adversary's pieces or pawns. The queen moves only in right lines, but her range is unlimited where the board is clear: thus she can go the whole breadth, or the whole length, or the whole diagonal of the board. If placed in the centre of the board she could, consequently, move in any one of the eight, *i. e.* four rectangular, and four diagonal directions, diverging from the square on which she might stand. The bishops always move in a diagonal direction, each invariably adhering to that colour on which he was originally placed; these pieces are called according to the colour on which they stand and move, without any reference to their own complexions respectively. Thus the

white party has a black and a white bishop; though they are both made of a white substance: the same holds in regard to the adversary's bishops. The knights have a circular move, always proceeding to such squares, within two distant, as may be of opposite colour to that from which they move; counting that square, say it be white, as one, the knight passes over one square, either black or white, and settles on a black square next thereto. Hence a knight can remove to or command eight squares, all in different directions from that on which he stands. The castles only move at right angles with the board; proceeding, if nothing should interrupt, either the whole length, or the whole breadth, at pleasure. The pawns have each the privilege of moving forward two squares, at the first move of each respectively, provided no obstacle should present itself; but ever after they can only move forward one square at a time. When pawns capture, they do it obliquely, but only at one square distance: thus a pawn, on a white square, can take any pawn or piece of the adversary's that may be on either of the diagonals proceeding from such white square, right and left, provided such pawn or piece be on the square next to that on which the pawn stands. Pawns never recede; all their moves are straight forward; they have, however, the great privilege of being changed for any piece the party they appertain to may choose, whenever they can reach that line on which the adversary's pieces were originally arranged: on such occasions the successful pawn is taken off the square, and any piece its owner may have lost is placed thereon in its stead. As a queen is usually chosen, where one has been lost, this is called making a queen.

A review of the chess board will show that every piece, as it stands on the board, protects one pawn, while each of the two centre pawns has four defences. The weakest parts of the board, are the pawns before the knights and bishops.

The king cannot remain in check, nor can he remove to a square that is commanded by any piece or pawn of the adversary. When he is so situated as to be liable to be taken, *i. e.* in check, and that he cannot move but into a similar situation, the game is ended, by what is called checkmate. When the party cannot move any of his pieces or pawns, and his king is not in check, or, as it is called, *en prise*, but would be so if he moved, he wins the game, under the plea of stale-mate. To effect this, when the party has lost his defences, is therefore an object of moment. Young players, when carrying all before them, very frequently give their adversaries this negative victory, by pushing on, without attending to the consequences of too closely confining the opponent's king.

When the space between the king and either castle is clear, and, that neither the king nor castle are *en prise*, the castle may then be brought next to the king, and the king be placed on the opposite side of the castle; this is called castleing, but can only be done once in the game, and before either the king or the castle have made any move. If either the king, or castle, crosses or comes upon a square that is commanded by a piece or pawn belonging to the adversary, the castleing cannot be allowed.

This operation is resorted to, either for the purpose of withdrawing the king from an attack directed against the square on which he is placed, or against that of his pawn; or it is used as the means of opening a communication between the two castles, when all the intermediate pieces are removed; or to strengthen the defence of the centre pawns, as well as to carry the game into the centre of the adversary's board. It is to be remarked, that the centre is ever to be strongly defended, if the measures pursued by the other party should admit. When the lateral game is played, that defence must be adopted which circumstances demand. The judicious chess player never makes an useless move, nor leaves a pawn or a piece unprotected. He forms his plans regularly, so as to calculate with precision what would be the position of the pieces after four or five moves he has in contemplation may have been made. He looks more to the solidity of his measures, than to little ensnaring stratagems; though he will not fail to appear ignorant of such designs as he may perceive to be within the intention of his opponent; when he knows that by an affected inattention, or blindness, to the device, he can make a more immediate impression, and render the whole speculation, not only void, but the means of ruining its projector.

The game of chess has certainly some affinity to the art of war; but the analogy is not so strict as players generally suppose. We can, however, inform the amateurs of this pleasing species of contest, that a work is now in the press which cannot fail to

afford a treat, as it opens a new field for the display of skill, and teems with the most ample and interesting varieties.

CHEVRON, or CHEVERON, in heraldry, one of the honourable ordinaries of a shield, representing two rafters of an house, joined together as they ought to stand; it was anciently the form of the priestesses' head attire: some say it is a symbol of protection; others, of constancy; others, that it represents knights' spears, &c. It contains the fifth part of the field.

A chevron is said to be abased, when its point does not approach the head of the chief, nor reach farther than the middle of the coat; mutilated, when it does not touch the extremes of the coat; cloven, when the upper pieces are taken off, so that the pieces only touch at one of the angles; broken, when one branch is separated into two pieces; couched, when the point is turned towards one side of the escutcheon; divided, when the branches are of several metals, or when metal is opposed to colour; inverted, when the point is turned towards the point of the coat, and its branches towards the chief.

CHIEF, in heraldry, is that which takes up all the upper part of the escutcheon from side to side, and represents the ornaments used on a man's head.

CHILIAD, denotes a thousand of any things, ranged in several divisions, each of which contains that number.

CHILIAGON, in geometry, a regular plane figure of a thousand sides.

CHIMÆRA, in natural history, a genus of fishes of the Linnæan order Chondropterigious, and, according to Shaw, of the order Cartilagenei. Generic character: head pointed on the upper part; mouth placed beneath, with the upper lip five-cleft; cutting teeth two in front, both above and below. There are two species, *viz.* C. monstrosa or borealis, and C. callorynchus or australis. The former is remarkable for the singularity of its appearance; is a native of the northern seas, where it inhabits the deepest recesses, and preys on the smaller kind of fishes, as well as on various sorts of the mollusca and testacea tribes. It is about three or four feet long. Notwithstanding the Linnæan name of monstrosa, its appearance is not at all formidable, and its colours highly elegant. See Plate II. Pisces, fig. 5. The C. australis is a native of the southern seas, and its manner of life similar to that of the northern ocean.

CHIMARRHIS, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla funnel-form, with a very short tube; capsule inferior, obtuse, two-celled, two-valved, the valves bifid at the tip; seed one in each cell. There is but one species, *viz.* C. cymosa, a lofty tree, with a handsome head, the boughs spreading out horizontally. Flowers numerous, small, with white corollas, without scent; capsules small. The wood is white, and used for beams, rafters, &c. It is called in Martinico, where it is common, bois de reviere.

CHIMES *of a clock*, a kind of periodical music, produced at equal intervals of time, by means of a particular apparatus added to a clock.

CHIMNEY is that part of a house which serves to conduct the smoke of the fires to the exterior. This will not, however, be effected, unless the draught of air be decidedly from the bottom to the top. To insure this, the fire-place should be rather wide than narrow in the front, and gradually taper backwards, so as to proceed all the way up in rather a conical form, causing the smoke to rush forth with velocity. This is the great secret, the want of which, added to angular instead of curved lines, where bends are requisite in any part of the flue, and the being overtopped by adjoining buildings, trees, banks, &c. has caused much inconvenience. Some persons are so very particular in listing their doors, and in making apartments completely wind-tight, that the want of draught has occasioned the best constructed chimnies to smoke intolerably: a few holes made with a gimlet in the sashes have remedied the defect. When a chimney is very foul, so as to be choked in a certain degree, the soot will generally check the draught. Short flues are subject to repel the smoke, because the wind from above can so easily reach all the way down, which in long flues it cannot do. If it could be applied to general use, the form of a tile-kiln should be generally adopted for that of the chimney.

CHIMNEY *sweeping*. Smoke in its passage through a chimney deposits a great part of the soot, with which it is loaded, upon the sides of the flue, which causes danger from fire, and is besides apt to fall back into the room. It is therefore frequently necessary to have the flues cleaned. To effect this, various expedients have been resorted to, but that most commonly adopted is the use of climbing boys, who ascend within the chimney and sweep down

Plate II.

Fig.1. Balistes *maculatus: spotted file-fish* *Fig.2.* Blennius *viviparus: viviparous blenny.* –
Fig.3. Bodianus *pentacanthus: five-spined bodian.* *Fig.4.* Callionymus *lyra: gemmeous dragonet*
Fig.5. Chimæra *borealis: northern chimæra.*

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the soot. The evils of this disagreeable and unwholesome occupation to those engaged in it, are generally acknowledged, and of late years the public attention has been directed to this subject, and premiums offered for the discovery of methods which might be substituted to a practice so offensive to humanity.

In the year 1802, a number of public-spirited and wealthy persons associated for this purpose, and offered considerable premiums to those who might invent and bring into practice, a method of cleansing chimnies, by mechanical means, that should supersede the necessity of climbing boys. Feeling themselves, perhaps, inadequate to the task of carrying their laudable intentions into full execution, they applied to the "Society for the Encouragement of Arts, Manufactures," &c. in the Adelphi, requesting them to engage in it, and to offer premiums on the subject. In consequence of this application, the society offered their gold medal to the person who should invent the most effectual mechanical or other means for cleansing chimnies from soot, and obviating the necessity of children being employed within the flues. In a few months there were five candidates for this premium, whose several inventions were put to the test of experiment upon chimnies not less than 70 feet high. One of the inventions consisted of a set of brushes with pullies and weights, which were to be let down from the top of the chimney; but as the object was to find an apparatus to effect the purpose from the inside of the house, this was deemed unfit to accomplish the views of the society. Another gentleman proposed the plan of throwing gravel up the chimney by means of condensed air; the machine was tried, and deemed wholly inadequate to the purpose. A third apparatus consisted of elastic rods of whalebone and cane, with a brush at the end of the upper one, which was found to answer only in short and straight chimnies. The next consisted of laths several feet long, which locked into one another, and on the upper one was fixed an elastic expanding brush, which, in its ascending and contracted state, occupied a space of only six or eight inches, but which was to be opened, when forced to the top of the chimney, by means of a string attached to it the whole length of the rods. After many experiments before divers persons appointed to examine its merits, this was given up as ineffectual to the purpose required. The only remaining apparatus was invented by Mr. George Smart, the patentee of a method of making hollow masts for ships: to him, after a long series of practice, in which he has been almost uniformly successful, the gold medal was adjudged; he has received also, we believe, some other premiums for his invention. As his method is now practised by several persons in and near the metropolis, we shall give a more particular account of it. The principal parts of the machine are a brush, some rods or hollow tubes, that fasten into each other, by means of brass sockets, and a cord for connecting the whole together.

The method of using the machine is this: having ascertained, by looking up the chimney, what is the direction of the flue, a cloth is then to be fixed before the fireplace, with the horizontal bar, and the sides to be closed with two upright bars. The brush is introduced through the opening of the cloth, which opening is then to be buttoned, and one of the rods is to be passed up the cord into the socket on the lower end of the rod which supports the brush; the other rods are in like manner to be brought up one by one in succession, till the brush is raised somewhat above the top of the chimney, observing to keep the cord constantly tight, and when those rods which have a screw in the socket are brought up, they are to be placed on the purchase; the cord is to be put round the pulley and drawn very tight, and screwed down, by which all the rods above will be firmly connected together, and the whole may be regarded as one long flexible rod. In pulling the machine down, the edges of the brush striking against the top of the chimney, will cause it to expand, and there being a spring to prevent its contracting again, it will bring down the soot with it. In drawing down the machine, the person should grasp with his left hand the rod immediately above that which he is separating with his right hand, to prevent the upper ones from sliding down too soon. The rods, as they are brought down, are to be laid carefully one by one in as small a compass as possible, and arranged like a bundle of sticks.

This machine has been found useful in extinguishing fires in chimnies; for that purpose a coarse cloth is to be tied over the brush, dipped in water, and then passed up in the manner directed. After three years experience, Mr. Smart's machine has been found, in a great measure, to answer the

purposes for which it was intended; in the course of several thousand trials, it is ascertained that not more than one or two chimnies, at most, in a hundred, has resisted the passage of the brush. It is, however, of importance to observe, that the invention cannot be deemed in a state of perfection; soot from some coals adheres so strongly to the sides of the chimney and chimney-pot, that no brush will of itself bring it down, so that after a considerable time it may be expected that means must be found to scrape off the soot as the climbing boys now generally do: we wish therefore that such an addition to the apparatus could be devised, as should remedy this defect. It is well known that one cause of the smoking of chimnies is from the circumstance of the top of the chimney-pot being clogged with soot that adheres to the upper edge, which it is certain Mr. Smart's brush has in many instances failed to remove. He has done much to obviate an evil long complained of; an evil that has deprived of health, and eventually of life, a multitude of persons in their youth, that might for a long course of years have been useful to the community, and we wish to see in his hands the invention, so honourable to his talents, rendered still more useful by being more perfect. He has attained, with regard to making his brush ascend the chimney, all that can be expected, and instead of bringing up infants to climb the fiftieth or hundredth chimney which on account of the direction of the flue no apparatus can be made to ascend, other means may be adopted.

CHIOCOCCA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Rhubiaceæ, Jussieu. Essential character: corolla funnel-form, equal; berry one-celled, two-seeded, inferior. There are two species. C. racemosa, climbing snowberry-tree, or David's root, is a native of the West Indies; and C. barbata, a native of the Marquesas, Society and Friendly Islands, in the South Sea.

CHIONANTHUS, in botany, *fringe*, or *snowdrop tree*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla quadrifid, with the divisions extremely long; drupe with a striated nut. There are four species, of which C. Virginica, Virginia fringe-tree, or snowdrop-tree. Is common in South Carolina, where it grows by the sides of rivulets, and is rarely more than ten feet high; the leaves are as large as those of the laurel but are of a much thinner substance: the flowers come out in May, hanging in long bunches of a pure white colour, whence the inhabitants call it snowdrop-tree: and the flowers being cut into narrow segments, they give it the name of fringe-tree.

CHIROMANCY, a species of divination, drawn from the different lines and lineaments of a person's hand; by which means it is pretended the inclinations may be discovered.

CHIRONIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: corolla rotated; pistil declinate; stamens on the tube of the corolla; anthers finally spiral; pericarp two-celled. There are ten species, mostly natives of the Cape of Good Hope.

CHISSEL, an instrument much used in carpentry, masonry, joinery, sculpture, &c. and distinguished according to the breadth of the blade into half-inch chissels, quarter-inch chissels, &c. They have also different names, according to the different uses to which they are applied; as, 1. The former, used by carpenters, &c. just after the work is scribed: it is struck with a mallet. 2. The paring-chissel, which is used in paring off the irregularities made by the former: this is pressed with the workman's shoulder. 3. The skew-former cleanses acute angles with the point of its narrow edge. 4. The mortice-chissel, used in cutting deep square holes in the wood, for mortices: it is narrow, but thick and strong, to endure hard blows. 5. Socket chissels, having their shank made with a hollow socket at top, to receive a strong wooden sprig fitted into it with a shoulder. 6. Ripping-chissel, having a blunt edge, with no basil, used in tearing two pieces of wood asunder. And, 7. The gouge.

CHITON, in natural history, a genus of Vermes Testacea. Animal inhabiting the shell a doris: shell consisting of several segments or valves disposed down the back. There are 28 species. They differ very much in colour, and are found on almost every coast in the ocean. C. tuberculatus: shell seven-valved; body tuberculate: inhabits America: oblong-oval, narrow, with tubercles above disposed in quincunx; the sides cinereous, mixed with white, and marked with brown undulate bands; back greenish, with a broad, deep, black band. C. cinereus: shell eight-valved, smooth, carinate;

body reddish, with a subciliate border; inhabits the Norwegian seas among the roots of ulvæ; two lines long; depressed, and narrower before, with two longitudinal grooves down the back, bounding the ridge in the middle; when alive both the shell and animal are reddish, when dried cinereous.

CHIVALRY, in law, is a tenure of service, whereby the tenant is bound to perform some noble or military office to his lord; and is either regal, when held only of the king; or common, such as may be held of a common person, as well as the king: the former is properly called serjeanty, and the latter escuage.

Chivalry, in antiquity, an institution which, according to some writers, took its rise from the crusades; but, according to others, it gave occasion to that enterprise; and which, though founded in caprice, and productive of extravagance, had a very considerable influence in refining the manners of the European nations, during the twelfth, thirteenth, fourteenth, and fifteenth centuries.

This institution naturally arose, says Dr. Robertson, from the state of society at that period. The feudal state was a state of perpetual war, rapine, and anarchy; during which the weak and unarmed were exposed to perpetual insults or injuries. The power of the sovereign was too limited to prevent these wrongs; and the administration of justice too feeble to redress them. Against violence and oppression there was scarcely any protection, besides that which the valour and generosity of private persons afforded. The same spirit of enterprise which had prompted so many gentlemen to take arms in defence of the oppressed pilgrims in Palestine, incited others to declare themselves the patrons and avengers of injured innocence at home. When the final reduction of the Holy Land under the dominion of infidels put an end to these foreign expeditions, the latter was the only employment left for the activity and courage of adventurers. The objects of this institution were to check the insolence of overgrown oppressors, to succour the distressed, to rescue the helpless from captivity, to protect or to avenge women, orphans, and ecclesiastics, who could not bear arms in their own defence, to redress wrongs, and to remove grievances. These were considered as acts of the highest prowess and merit. Valour, gallantry, and religion, were blended in this institution; humanity, courtesy, justice, and honour were its characteristic qualities; the enthusiastic zeal produced by religion served to give it singular energy, and to carry it even to a romantic excess: men were trained to knighthood by long previous discipline; they were admitted into the order by solemnities no less devout than pompous; every person of noble birth courted the honour; it was deemed a distinction superior to royalty, and monarchs were found to receive it from the hands of private gentlemen. These various circumstances contributed to render a whimsical institution of substantial benefit to mankind.

Chivalry was employed in rescuing humble and faithful vassals from the oppression of petty lords; their women from savage lust; and the hoary heads of hermits (a species of Eastern monks, much reverenced in the Holy Land) from rapine and outrage. In the mean time the courts of the feudal sovereigns became magnificent and polite; and, as the military constitution still subsisted, military merit was to be upheld; but, destitute of its former objects, it naturally softened into fictitious images and courtly exercises of war, in "justs" and "tournaments;" where the honour of the ladies supplied the place of zeal for the holy sepulchre; and thus the courtesy of elegant love, but of a wild and fanatic species, as being engrafted on spiritual enthusiasm, came to mix itself with the other characters of the knights-errant.

Chivalry, whatever might be the era of its origin, declined in England during the inglorious reigns of King John and Henry III.; but revived under Edward I. This prince was one of the most accomplished knights of the age in which he flourished, and both delighted and excelled in feats of chivalry. As a proof of this, it will be sufficient to allege, that when he was on his return from the Holy Land after his father's death, and knew that his presence was ardently desired in England, he accepted an invitation to a tournament at Chalons in Burgundy, where he displayed his skill and valour to great advantage, and gained a complete victory. Edward III. was no less fond of chivalry, and encouraged it both by his example and munificence. Having formed the design of asserting his claim to the crown of France, he laboured to inspire his own subjects with a bold enterprising spirit, and to entice as many valiant foreigners as possible into his service.

"This singular institution, says Dr. Ro-

bertson, in which valour, gallantry, and religion, were so strangely blended, was wonderfully adapted to the taste and genius of martial nobles; and its effects were soon visible in their manners. War was carried on with less ferocity, when humanity came to be deemed the ornament of knighthood no less than courage. More gentle and polished manners were introduced, when courtesy was recommended as the most amiable of knightly virtues. Violence and oppression decreased, when it was reckoned meritorious to check and to punish them. A scrupulous adherence to truth, with the most religious attention to fulfil every engagement, became the distinguishing characteristic of a gentleman, because chivalry was regarded as the school of honour, and inculcated the most delicate sensibility with respect to that point. The admiration of these qualities, together with the high distinctions and prerogatives conferred on knighthood in every part of Europe, inspired persons of noble birth, on some occasions, with a species of military fanaticism, and led them to extravagant enterprises. But they imprinted deeply on their minds the principles of generosity and honour. These were strengthened by every thing that can affect the senses or touch the heart. The wild exploits of those romantic knights who sallied forth in quest of adventures, are well known, and have been treated with proper ridicule. The political and permanent efforts of the spirit of chivalry have been less observed. Perhaps, the humanity which accompanies all the operations of war, the refinements of gallantry, and the point of honour, the three chief circumstances which distinguish modern from ancient manners, may be ascribed in a great measure to this whimsical institution, seemingly of little benefit to mankind. The sentiments which chivalry inspired had a wonderful influence on manners and conduct during the twelfth, thirteenth, fourteenth, and fifteenth centuries. They were so deeply rooted, that they continued to operate after the vigour and reputation of the institution itself began to decline." In a word, chivalry, which is now an object of ridicule, was, at the period to which we have above referred, a matter of the greatest moment, and had no little influence on the manners of mankind, and the fate of nations.

A respectable writer has traced, with ingenuity and much learning, a strong resemblance between the manners of the age of chivalry and those of the heroic ages delineated by Homer. See Letters on Chivalry, &c.

CHLORA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: calyx eight-leaved; corolla one-petalled, eight-cleft; capsule one-celled, two-valved, many-seeded. Stigma four-cleft. There are four species.

CHLORANTHUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Essential character: calyx none; corolla a petal three-lobed by the side of the germ; anthers growing to the petal; drupe one-seeded. There is but one species.

CHLORIS, in botany, a genus of the Polygamia Monoecia class and order. Hermaphrodite calyx, glume two-valved, two-flowered, awned; corolla none; stamina three; styles two; seed one; male calyx, glume one-valved: female sessile; calyx, glume two-valved. There are five species, natives of the West Indies.

CHLOROSIS, in medicine, a disease commonly called the green-sickness. See MEDICINE.

CHOCOLATE is made of roasted cocoa, which being first coarsely pounded in a stone mortar, is afterwards levigated on a slab of the finest grained marble; to this a small quantity of vanilla is added. The mixture is heated, sometimes with cream, and put into tin moulds of the size in which the cakes appear. Chocolate is nutritive, and not unwholesome, provided the stomach be active, and that exercise be not neglected: it would be less objectionable if the vanilla were omitted, that being of a very heating quality, but on it the flavour chiefly depends. Manufactured chocolate, and cocoa-paste, are prohibited from importation under severe penalties. See THEOBROMA.

CHOIR, that part of the church or cathedral where choristers sing divine service: it is separated from the chancel, where the communion is celebrated; and also from the nave of the church, where the people are placed; the patron is said to be obliged to repair the choir of the church.

CHOMELIA, in botany, a genus of the Tetrandria Monogynia class and order. Calyx four-parted; corolla salver-shaped, four-parted; drupe inferior, with a two-celled nut; stigmata two, thickish. One species, found in America.

CHONDRILLA, in botany, a genus of Syngenesia Polygamia Æqualis class and

order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled; floscules in many rows; seeds muricated; pappus simple, stipitated. There are three species.

CHONDROPTERIGIOUS, a term applied by the Linnæan system to an order of fishes with cartilaginous gills. Dr. Shaw, and other naturalists, have united the Branchiostegi and Chondropterygii under the general title of Cartilaginei. Linnæus separated the cartilaginous from the other fishes, and placed them in the class Amphibia, where they constituted the order Nantes. This distribution was made under the supposition of the cartilaginous fishes being furnished both with lungs and gills. The supposed lungs, however, have been since ascertained by naturalists to be only a modification of the gills, and it, therefore, now appears that this cartilaginous tribe are in reality fishes, differing principally, if not entirely, from other fishes, in having a cartilaginous skeleton. They differ from the generality of other fishes, in having gills destitute of bony rays, or in the gills being cartilaginous, and they are deficient for the most part at least of obvious scales, those being either very deciduous, minute, or so deeply imbedded in the skin, as to be scarcely visible. In many of the cartilaginous fishes there is not the slightest appearance of scales on the surface of the skin. The Chondropterigii genera are

Acipenser	Chimæra	Gastrobranchus
Petromyzor	Pristis	Raia
Squalus: which see.		

CHORD *of an arch* is a right line joining the extremes of that arch.

CHORD *of the complement of an arch*, the chord that subtends the rest of the arch, or so much as makes up the arch a semicircle.

It is demonstrated in geometry, that the radius bisecting the chord also bisects the arch, and is perpendicular to the chord. From hence may be deduced these problems; 1. To make a circle pass through any three given points, not lying in a right line. 2. To find the centre of any circle. 3. To complete a circle from an arch given. 4. To describe a circle about any triangle given.

CHORDS, *line of*, one of the lines of the sector and plane scale. See INSTRUMENTS, *mathematical*.

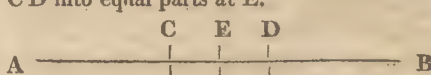
CHORDS, or CORDS, in music, are strings, by the vibration of which the sensation of sound is excited, and by the divisions of which the several degrees of tune are determined.

The chords of musical instruments are ordinarily made of cat-gut; though some are made of brass or iron wire, as those of harpsichords, spinnets, &c. Chords of gold-wire in harpsichords would yield a sound almost twice as strong as those of brass; and those of steel a feebler sound than those of brass, as being both less heavy and less ductile.

The rules for dividing chords so as to constitute any given interval, are as follow: to assign such part of a chord A B as shall constitute any concord; for example, a fifth, or any other interval, with the whole chord: divide the line A B into as many parts as the greatest number of the interval has units; thus the fifth being 2 : 3, the line is divided into

three parts: of these take as many as the lesser number 2 = A C, then is A C the part sought; that is, two lines whose lengths are to each other as A B to A C, make a fifth. Hence if it be required to find several different sections of the line A B, for instance, such as shall be octave, fifth, or third greater; reduce the given ratios 1 : 2, 2 : 3, and 4 : 5 to one fundamental, the series becomes 30 : 24, 20 : 15, the fundamental is 30, and the sections sought are 24 the third greater, 20 the fifth, and 15 the octave.

To divide a chord A B in the most simple manner, so as to exhibit all the original concords. Divide the line into two equal parts at C, and subdivide the part C D into equal parts at D, and again the part C D into equal parts at E.



Here A C : A B is an octave, A C : A D a fifth, A D : A B a fourth, A C : A E a third greater; A E : A D a third less; A E : E B a sixth greater; A E : A B a sixth less.

CHORD is also used in music for the note or tone to be touched or sounded: in this sense the fifth is said to consist of five chords or sounds.

CHORDOSTYLUM, in botany, a genus of the Cryptogamia Fungi. Fungus tenacious; on a very long, tough, slightly branched stem; head globular, somewhat deciduous, bearing the seeds. There are five species.

CHORION, in anatomy, the exterior membrane which invests the fœtus in the uterus.

CHOROGRAPHY, the art of delineating or describing some particular country or province: it differs from geography as a description of a particular country differs from that of the whole earth; and from topography, as a description of a country differs from that of a town or district.

CHOROIDES, in anatomy, an epithet of several membranes, which on account of the multitude of their blood-vessels resemble the chorion.

Choroides denotes the coat of the eye placed immediately under the sclerotica. It is very full of vessels, and coloured black.

CHORUS, in dramatic poetry, one or more persons present on the stage during the representation, and supposed to be bystanders without any share in the action. Tragedy in its origin was no more than a single chorus, who trod the stage alone, and without any actors, singing dithyrambics or hymns in honour of Bacchus. Thespis, to relieve the chorus, added an actor, who rehearsed the adventures of some of their heroes; and Æschylus, finding a single person too dry an entertainment, added a second, at the same time reducing the singing of the chorus, to make more room for the recitation. But when once tragedy began to be formed, the recitative, which at first was intended only as an accessory part to give the chorus a breathing time, became a principal part of the tragedy. At length, however, the chorus became inserted and incorporated into the action: sometimes it was to speak, and then their chief, whom they called Coryphæus, spoke in behalf of the rest: the singing was performed by the whole company; so that when the Coryphæus struck into a song, the chorus immediately joined him.

The chorus sometimes also joined the actors in the course of the representation, with their plaints and lamentations on account of any unhappy accidents that befel them: but the proper function, and that for which it seemed chiefly retained, was to show the intervals of the acts: while the actors were behind the scenes, the chorus engaged the spectators; their songs usually turned on what was exhibited, and were not to contain any thing but what was suited to the subject, and had a natural connection with it; so that the chorus concurred with the actors for advancing the action. In the modern tragedies the chorus is laid aside, and the music supplies its place.

CHORUS, in music, is when, at certain periods of a song, the whole company are to join the singer in repeating certain couplets or verses.

CHRISTIANITY, the religion of Christians, who derive their name from the founder, Christ, so denominated from the Greek word χριω, I anoint, from the custom of anointing persons in the sacerdotal or regal character, as a public signal of their separation to important offices. After the death of Jesus, his disciples were for some years called Nazarenes, from Nazareth, where he was brought up. This name afterwards became the designation of a particular sect; and we learn from a passage in the Acts of the Apostles, that about the year 42, they who adopted the principles and professed the religion which Jesus had taught, and for the sake of which he cheerfully laid down his life, were distinguished by the name of Christians at Antioch. Hence the system itself is called Christianity. The foundation of a Christian's faith and practice, his ultimate, and, in truth, his only appeal, must be to the facts, the doctrines, and the precepts of the Scriptures, particularly those of the New Testament. Other formularies, other confessions of faith, from whatever motives dictated, and from whatever reasons recommended, should ever be regarded with a suspicious eye; lest, by laying stress upon what is human, we should overlook that which comes recommended upon divine authority. The careful reader of the New Testament will find a detail of instructions given, of wonders performed, and of future events revealed. He will also be struck with a very particular account of the sufferings, death, resurrection, and ascension of Jesus the founder. The history containing these things appears to be fairly written, and to carry with it as substantial proofs of its authenticity, as any history that has gained credit in the world. Is the Christian called upon for the reason why he believes in the antiquity of the writings of the New Testament? he may reply, "For the same reason that I believe the antiquity of Virgil's poems, Cæsar's Commentaries, or Sallust's narrations: and that is, the concurring testimony of all intervening ages. Do any ask, Why I believe that the several books were written by the persons whose names they bear? I answer, For the same reason that I believe the Georgics to be the production of Virgil;

Jerusalem Delivered, that of Tasso; Paradise Lost, that of Milton; an Essay upon the Subject of Miracles, to be the work of Hume; and a Refutation of that Essay, the performance of Campbell. Do any inquire, Whether the sacred pages have not been greatly corrupted? I answer, They have not been greatly corrupted; as appears by a collation of the earliest manuscripts, and an appeal to the earliest versions and ancient fathers. So many corroborating circumstances plead in favour of the Gospel, that I must either disturb all records, or continue to admit the authenticity of those which display the duty and hopes of a Christian."

In reasoning upon the truth of Christianity we may appeal to its internal evidence, and combining the doctrine and precepts of the system, infer from them the validity of the system itself. The early triumphs of this religion furnish another powerful argument in its support: especially if it be remembered that in the estimation of the world it was neither honourable, profitable, nor popular. Under every disadvantage, and struggling under the most terrible persecution, it flourished, and has maintained its ground for nearly two thousand years. Another argument for the truth of the Christian religion arises from the completion of prophecies, of which some preceded Jesus, and were accomplished in him, and others were uttered by him, and came to pass during his life; such were the treachery of Judas, and the cowardice and meanness of Peter: or within a few years after his crucifixion; of this kind was the memorable destruction of Jerusalem. The character of Christ, and the miracles which he wrought, are evidences of the divinity of his mission. On these grounds if the question be put "Why are you a Christian?" the answer has been given by a good writer, from whom we shall transcribe it. "Not because I was born in a Christian country, and educated in Christian principles; not because I find the illustrious Bacon, Boyle, Locke, Clarke, and Newton, among the professors and defenders of Christianity; nor merely because the system itself is so admirably calculated to mend and exalt human nature; but because the evidence accompanying the Gospel has convinced me of its truth. The secondary causes, assigned by unbelievers, do not, in my judgment, account for the rise, progress, and early triumphs of the Christian religion. Upon the principles of scepticism, I perceive an effect without an adequate cause. I therefore stand acquitted to my own reason, though I continue to believe and profess the religion of Jesus Christ. Arguing from effects to causes, I think I have philosophy on my side. And reduced to a choice of difficulties, I encounter not so many, in admitting the miracles ascribed to the Saviour, as in the arbitrary suppositions and conjectures of his enemies.

"That there once existed such a person as Jesus Christ; that he appeared in Judea in the reign of Tiberius; that he taught a system of morals superior to any inculcated in the Jewish schools; that he was crucified at Jerusalem; and that Pontius Pilate was the Roman governor by whose sentence he was condemned and executed, are facts which no one can reasonably call in question. The most inveterate Deists admit them without difficulty: and, indeed, to dispute these facts would be giving the lie to all history. As well might we deny the existence of Cicero, as that of a person by the name of Jesus Christ. And with equal propriety might we call in question the orations of the former, as the discourses of the latter. We are morally certain that the one entertained the Romans with his eloquence, and that the other enlightened the Jews with his wisdom. But it is unnecessary to labour these points, because they are generally conceded. They who affect to despise the Evangelists and Apostles profess to reverence Tacitus, Suetonius, and Pliny. And these eminent Romans bear testimony to several particulars which relate to the person of Jesus Christ, his influence as the founder of a sect, and his crucifixion. From a deference to human authority, all therefore acknowledge that the Christian religion derived its name from Jesus Christ. And many among the Deists are so just to its merits, as to admit that he taught better than Confucius, and practised better than Socrates or Plato.

"To come then to the question: Why are you a Christian? I answer, Because the Christian religion carries with it internal marks of its truth; because not only without the aid, but in opposition to the civil authority, in opposition to the wit, the argument, and violence of its enemies, it made its way, and gained an establishment in the world; because it exhibits the accomplishment of some prophecies, and presents others which have been since fulfilled; and because its author displayed an example, and performed works, which bespeak

not merely a superior but a divine character. Upon these several facts I ground my belief as a Christian. And, till the evidence on which they rest can be invalidated by counter evidence, I must retain my principles and my profession."

CHROMATICS, is that part of optics which explains the several properties of the colours of light, and of natural bodies.

Before the time of Sir Isaac Newton, the notions concerning colour were very vague. Des Cartes accounted colour a modification of light; and he imagined that the difference of colour proceeds from the prevalence of the direct or rotatory motion of the particles of light. Grimaldi, Dechales, and many others, imagined that the differences of colour depended upon the quick or slow vibrations of a certain elastic medium with which the universe is filled. Rohault conceived, that the different colours were made by the rays of light entering the eye at different angles with respect to the optic axis. And Dr. Hooke imagined that colour is caused by the sensation of the oblique or uneven pulse of light; which being capable of no more than two varieties, he concluded there could be no more than two primary colours.

Sir Isaac Newton, in the year 1666, began to investigate this subject; when finding that the coloured image of the sun, formed by a glass prism, was of an oblong, and not of a circular form, as, according to the laws of equal refraction, it ought to be, he conjectured that light is not homogeneal; but that it consists of rays of different colours, and endued with divers degrees of refrangibility. And, from a farther prosecution of his experiments, he concluded that the different colours of bodies arise from their reflecting this or that kind of rays most copiously. This method of accounting for the different colours of bodies soon became generally adopted, and still continues to be the most prevailing opinion. It is hence agreed that the light of the sun, which to us seems white and perfectly homogeneal, is composed of no fewer than seven different colours, *viz.* red, orange, yellow, green, blue, purple, and violet or indigo: that a body which appears of a red colour has the property of reflecting the red rays more plentifully than the rest; and so of the other colours, the orange, yellow, green, &c.: also that a body which appears black, instead of reflecting, absorbs all or the most part of the rays that fall upon it; while, on the contrary, a body which appears white, reflects the greater part of all the rays indiscriminately, without separating them one from another.

The foundation of a rational theory of colours being thus laid, the next inquiry was, by what peculiar mechanism, in the structure of each particular body, it was fitted to reflect one kind of rays more than another, and this is attributed by Sir I. Newton, to the density of these bodies. Dr. Hooke had remarked, that thin transparent substances, particularly soap-water blown into bubbles, exhibited various colours, according to their thinness; and yet, when they have a considerable degree of thickness, they appear colourless. And Sir Isaac himself had observed, that as he was compressing two prisms hard together, in order to make their sides (which happened to be a little convex) to touch one another, in the place of contact they were both perfectly transparent, as if they had been but one continued piece of glass: but round the point of contact, where the glasses were a little separated from each other, rings of different colours appeared. And when he afterwards, farther to elucidate this matter, employed two convex glasses of telescopes, pressing their convex sides upon one another, he observed several series of circles or rings of such colours, different, and of various intensities, according to their distance from the common central pellucid point of contact.

As the colours were thus found to vary according to the different distances between the glass plates, Sir Isaac conceived that they proceeded from the different thickness of the plate of air intercepted between the glasses; this plate of air being, by the mere circumstance of thinness or thickness, disposed to reflect or transmit the rays of this or that particular colour. Hence, therefore, he concluded, that the colours of all natural bodies depend on their density, or the magnitude of their component particles: and hence also he constructed a table, in which the thickness of a plate necessary to reflect any particular colour was expressed in the millionth parts of an inch.

From a great variety of such experiments, and observations upon them, our author deduced his theory of colours. And hence it seems that every substance in nature is transparent, provided it be made sufficiently thin; as gold, the densest substance we know of, when reduced into thin leaves, transmits a bluish-green light through it. If we suppose any body, therefore, as

gold, for instance, to be divided into a vast number of plates, so thin as to be almost perfectly transparent; it is evident that all, or the greatest part of the rays, will pass through the upper plates, and when they lose their force will be reflected from the under ones. They will then have the same number of plates to pass through which they had penetrated before; and thus, according to the number of those plates through which they are obliged to pass, the object appears of this or that colour, just as the rings of colours appeared different in the experiment of the two plates, according to their distance from one another, or the thickness of the plate of air between them.

This theory of the colours has been illustrated and confirmed by various experiments, made by other philosophers. Mr. Delaval produced similar effects by the infusions of flowers of different colours, and by the intimate mixture of the metals with the substance of glass, when they are reduced to very fine parts; the more dense metals imparting to the glass the less refrangible colours, and the lighter ones those colours that are more easily refrangible. Dr. Priestley and Mr. Canton also, by laying very thin leaves or slips of the metals upon glass, ivory, wood, or metal, and passing an electrical stroke through them, found that the same effect was produced; *viz.* that they were tinged with different colours, according to the distance from the point of explosion.

Mr. Delaval has given also an account of some experiments made upon the permanent colours of opaque substances, which may prove of great importance in the arts of dying, &c.

The changes of colour in permanently coloured bodies, he observes, are produced by the same laws that take place in transparent colourless substances; and the experiments by which they are investigated consist chiefly of various methods of uniting the colouring particles into larger masses, or dividing them into smaller ones. Sir Isaac Newton made his experiments chiefly on transparent substances; and in the few places where he treats of others, he acknowledges his want of experiments. He makes the following remark, however, on those bodies which reflect one kind of light and transmit another, *viz.* that if these glasses or liquors were so thick and massy that no light could get through them, he questioned whether they would not, like other opaque bodies, appear of one and the same colour in all positions of the eye; though he could not yet affirm it from experience. Indeed it was the opinion of this great philosopher, that all coloured matter reflects the rays of light; some reflecting the more refrangible rays most copiously, and others those that are less so; and that this is at once the true and only reason of these colours. He was likewise of opinion that opaque bodies reflect the light from their anterior surface, by some power of the body evenly diffused over and external to it. With respect to transparent coloured bodies, he thus expresses himself: "A transparent body which looks of any colour by transmitted light, may also look of the same colour by reflected light; the light of that colour being reflected by the farther surface of that body, or by the air beyond it: and then the reflected colour will be diminished, and perhaps cease, by making the body very thick, and pitching it on the back-side to diminish the reflection of its farther surface, so that the light reflected from the tinging particles may predominate. In such cases the colour of the reflected light will be apt to vary from that of the light transmitted."

To search out the truth of these opinions, Mr. Delaval entered upon a course of experiments with transparent coloured liquors and glasses, as well as with opaque and semitransparent bodies. And from these experiments he discovered several remarkable properties of the colouring matter; particularly, that in transparent coloured substances it does not reflect any light; and when, by intercepting the light which was transmitted, it is hindered from passing through such substances, they do not vary from their former colour to any other, but become entirely black.

This incapacity of the colouring particles of transparent bodies to reflect light, being deduced from very numerous experiments, may therefore be taken as a general law. It will appear the more extensive if it be considered that, for the most part, the tinging particles of liquors, or other transparent substances, are extracted from opaque bodies; that the opaque bodies owe their colours to those particles in like manner as the transparent substances do; and that by the loss of them they are deprived of their colours.

Notwithstanding these and many other experiments the theory of colour seems not yet determined with certainty. The dis-

coveries of Sir Isaac Newton, however, are sufficient to justify the following aphorisms.

1. All the colours in nature arise from the rays of light. 2. There are seven primary colours; namely, red, orange, yellow, green, blue, indigo, and violet. 3. Every ray of light may be separated into these seven primary colours. 4. The rays of light, in passing through the same medium, have different degrees of refrangibility. 5. The difference in the colours of light arises from its different refrangibility; that which is the least refrangible producing red; and that which is the most refrangible violet. 6. By compounding any two of the primary, as red and yellow, or yellow and blue, the intermediate colour, orange or green, may be produced. 7. The colours of bodies arise from their dispositions to reflect one sort of rays and to absorb the others: those that reflect the least refrangible rays appearing red, and those that reflect the most refrangible violet. 8. Such bodies as reflect two or more sorts of rays, appear of various colours. 9. The whiteness of bodies arises from their disposition to reflect all the rays of light promiscuously. 10. The blackness of bodies proceeds from their incapacity to reflect any of the rays of light. And from their thus absorbing all the rays of light that are thrown upon them, it arises, that black bodies, when exposed to the sun, become hot sooner than all others.

Sir Isaac Newton, in the course of his investigations of the properties of light, discovered that the lengths of the spaces occupied in the spectrum by the seven primary colours exactly correspond to the lengths of chords that sound the seven notes in the diatonic scale of music; which is made evident by an experiment. On a paper, or other fit substance, in a darkened room, let a ray of light be refracted by means of a prism into a spectrum of some size, marking upon it the precise boundaries of the several colours: and it will be found that the spaces by which the several colours are bounded, *viz.* the space containing the red, that containing the orange, yellow, &c. will be in exact proportion to the divisions of a musical chord for the notes of an octave; that is, as the intervals of these; 1; $\frac{8}{9}$; $\frac{5}{6}$; $\frac{3}{4}$; $\frac{2}{3}$; $\frac{3}{5}$; $\frac{9}{16}$; $\frac{1}{2}$. See COLOURS, OPTICS, &c.

CHROME, a metal discovered by Vauquelin. It exists in the state of an acid, combined with oxide of lead, in a beautiful mineral named red lead, found in Siberia, and with regard to which very discordant analyses had been given by different chemists. Vauquelin reduced the metallic acid which he discovered in it to the metallic state, and his researches have been confirmed by those of Klaproth and Gmelin. It derives its name from the splendid and numerous colours which it presents in its saline combinations. It has since been discovered in various minerals. The native chromate of lead, or the red lead of Siberia, is generally crystallized in oblique tetrahedral prisms. Its colour is a fine aurora red; its lustre shining, and intermediate between adamantine and resinous; the crystals are translucid; the fracture is uneven; the specific gravity 6.0269. It decrepitates before the blow-pipe, and melts into a blackish scoria. It colours borax green by fusion. According to Vauquelin, it is composed of 57.10 of lead, 6.86 of oxygen, and 36.04 of chromic acid. There is found with the chromate of lead, a mineral of a green colour in minute crystals, which Vauquelin found to be composed of the oxides of chrome and lead, and which, as he conjectures, has probably originated in the decomposition of the perfect chromate, from some process by which part of its oxygen has been abstracted.

Native chromate of iron has more lately been found in the department of Var in France, and likewise in Siberia. This mimineral is massive, of a blackish brown colour, with no great lustre and opaque; its fracture is uneven, and it is hard and difficult to break; its specific gravity is 4.0. It is scarcely fusible before the blow-pipe, but with borax it melts into a glass of a fine green colour. According to an accurate analysis of it, it consists of 63.6 of chromic acid, or perhaps rather oxide of chrome, and 36 of oxide of iron.

Chrome has been also found in smaller quantities in other minerals, particularly in some gems, of which it appears to be the colouring principle. It exists in the emerald, in the state of green oxide, and in the spinal ruby, in the state of acid.

Vauquelin extracted the metal from the red lead ore, by adding to it muriatic acid, which combines with the oxide of lead, and forms a compound that is precipitated, the chromic acid remaining in solution. To abstract a little muriatic acid combined with it, oxide of silver is cautiously added, and the pure chromic acid being decanted from the precipitate of muriate of silver, and evaporated, is exposed to a very strong heat excited by a forge, in a crucible of char-

coal, placed within another of porcelain. It is thus reduced to the metallic state. It is to this chemist that we are indebted principally for a knowledge of its properties.

Chrome is of a white colour, inclining to grey; it is very brittle; its fracture presents a radiated appearance, needles crossing in different directions with interstices between them. Its other physical qualities have not been determined. This metal is difficult of fusion. Exposed to the heat of the blow-pipe it does not melt. When fused by having been exposed to the intense heat necessary to its reduction, it presents crystalline filaments, which rise above the metallic mass. Chrome is not easily acted on by the acids. Even when reduced to a fine powder, and treated with concentrated boiling nitric acid, it is oxydized with much difficulty, and communicates to the acid only a green tinge.

Chrome, in the state of acid, appears to be more susceptible of combination, and this acid being obtained without difficulty from its native combinations, its chemical relations have been more examined. Chromic acid is very soluble in water; the taste of the solution is sharp and metallic; it is of an orange-red colour; by evaporation, either spontaneous or with a gentle heat, it affords crystals in long slender prisms, of a ruby-red colour. This acid combines with the alkalies, earths, and metallic oxides, forming neutral salts which are named chromates.

The combinations of this acid with metallic oxides are in general possessed of very beautiful colours, and are well adapted to form the finest paints. That with oxide of lead has an orange yellow, of various shade; that with mercury, a vermillion red; with silver, a carmine red; with zinc and bismuth, the colours are yellow; with copper, cobalt, and antimony, they are dull.

CHRONOLOGY, is that science which relates to time, treats of the division of it into certain portions, as days, months, years, centuries, and the application of these portions, under various forms and combinations, as cycles, æras, &c. to the elucidation of history. What is proposed in the present article is, to point out the chief methods by which the several portions of time have been computed, and in which they have been employed in ascertaining the connection, and determining the dates, of past transactions.

The divisions of time which most probably first attracted the notice of mankind, as most obvious to their senses, were those marked by the revolutions of the heavenly bodies, days, lunar months, and years: and if these had corresponded so exactly to each other, that every lunation had consisted uniformly of the same number of days, and each year of a regular number of complete lunations, the business of chronology would have been attended with comparatively little difficulty. In consequence, however, of variations in the revolutions of the earth, which it is not requisite here to explain, it has become necessary to adjust these periods to each other by certain artificial divisions. Of these divisions:

The Day claims our first notice. In common speech, a day means that period of time which is included between the first appearance of light in the morning, and the return of darkness in the evening, or during which the sun is visible above the horizon. But the word is used, in a more comprehensive sense, to denote the time of a complete revolution of the earth round its axis. The former has been denominated a natural, the latter a civil, and sometimes a solar, day. The beginning of the day has been variously reckoned by different nations. The Chaldæans, Syrians, Persians, and Indians, reckoned the day to commence at sun-rise. The Jews, also, used this method for their civil, but began the sacred day at sun-set: this latter mode was used likewise by the Athenians, the Arabs, the ancient Gauls, and some other European nations. The Egyptians appear to have had several methods of reckoning their day; probably the mode varied in different parts of the country, and in the same place at different periods. The ancient inhabitants of Italy computed the day from midnight, and in this they have been followed by the English, French, Dutch, Germans, Spaniards, and Portuguese; modern astronomers, after the Arabians, count the day from noon.

The day was subdivided by the Jews and Romans into four parts, which they denominated watches or vigils: the first commenced at six in the morning, the second at nine, the third at twelve, and the fourth at three in the afternoon. The beginning of the first watch was, by the Jews, called the third hour, and so on in succession to the fourth watch, which was reckoned the twelfth hour. The night was divided in a similar manner. Other modes

of dividing the day have been in use among different nations; but that which is now most general in civilized countries is into twenty-four equal parts or hours. With respect to the different inventions which have been used for measuring, or distinguishing the hours of the day, we refer to the articles CLEPSYDRA, CLOCK, SUN-DIAL, &c.

The Week, is a division of time of which it may be proper to take some notice before we proceed to the month. Various divisions which might be included under this denomination have obtained in different countries. The earlier Greeks divided their month into three portions of ten days each: the Northern Chinese had a week of fifteen days, and the Mexicans one of thirteen. But the Chaldæans, and most other Oriental nations, have, from time immemorial, used the Jewish week of seven days, which has been adopted by the Mahommedans, and introduced, with christianity, to most of the civilized nations of the world. In the Old Testament the term week is occasionally applied to a period of seven years, as well as of seven days; and to this it is necessary to attend, in order to understand the passages wherein the word is used in that sense.

The Month. There can be little doubt, but that this division of time was at first suggested by the phases, or the periodical change in the appearances of the moon, and consequently, that in ancient computations the months were invariably lunar. The difficulty, however, of adjusting this month to the annual revolution of the earth, led, with the improvement of astronomy, to the invention of other divisions under this name. Months are now divided into astronomical and civil. The astronomical months with which chronology is concerned, are measured by the revolutions of the moon, and are either periodical or synodical. The periodical lunar month is composed of the time which elapses between the departure of the moon from any part of her orbit, and her return to the same point, which is 27 days, 7 hours, and 43 minutes. The synodical lunar month is reckoned from one conjunction of the sun with the moon to another. This period is not always the same, being subject to the variation occasioned by the motion of the sun eastward on the ecliptic: a mean lunation consists of 29 days, 12 hours, and 44 minutes. This was the lunar month mostly in use in ancient times. The civil month is that artificial space of time, by means of which the solar year is divided into twelve parts: these months, which were first ordained by Julius Cæsar, consist of thirty, or thirty-one days each, with the exception of February, which commonly contains twenty-eight, and every fourth year twenty-nine, days.

Years. The year may be termed the largest natural division of time. As the diurnal revolution of the earth would naturally lead to the division into days, and the phases of the moon, with a little attention, to that into months, so the annual motion of the earth round the sun, which would be marked by the periodical return of certain appearances, seasons, &c. would in due course lead to the adoption of this larger division. At what time this took place is uncertain, but probably not before considerable advances had been made in astronomical science. It was long, however, after its first adoption, before it attained to any thing like an accurate form. The most ancient measure of the year of which we know, consisted of twelve lunar months, which, for the facility of computation, being all considered as equal in length, and to contain thirty days each, amounted to 360 days. It is conjectured that this gave rise to the division of the ecliptic, which still obtains, into 360 equal parts or degrees.

This luni-solar year probably had its rise in Chaldæa, or Egypt; we learn, at least, from the testimony of Herodotus, that it was used in the latter country. Hence, with the diffusion of science, it was carried into other regions, and very generally adopted. It was early in use among the Indians, Chinese, the Medes, and Persians, and the ancient Greeks. Its measure being, however, inaccurate, containing five days and a quarter more than the lunar, and as much less than the true solar year, and this defect becoming every year more perceptible from the retrocession of the seasons, &c. it was soon considered necessary to subject it to some revision. The Thebans are supposed to have been the first who undertook its correction, by making an annual addition of five days to the luni-solar year. Thales introduced this improvement into the ancient Grecian year, and it was adopted, with some trifling variations in particular instances, into the Indian, the Chinese, and the Jewish year.

The Roman year, as regulated by Romulus, and afterwards reformed by his suc-

cessor Numa, was reckoned by lunar months, and adjusted to the seasons by a number of intercalary days. It consisted of ten lunar months, of which December was the last, and to these two whole intercalary months were added, but not inserted in the calendar. This year began at first in March; but the Decemviri, who undertook its reformation, changed the order of the months into that in which they now stand, introduced the two intercalary months, January and February, into the calendar, and made January the first month of the year.

Owing to the ignorance, or the carelessness, of the Pontifices Maximi, to whose care the regulation of the intercalary days was committed, the year was reduced to such disorder in the time of Julius Cæsar, that the winter months had fallen back to the autumn. To restore them to their proper season, Cæsar formed a year of 445 days, which has been styled the year of confusion. With the assistance of Sosigenes, a mathematician of Alexandria, he afterwards, in the year B. C. 45, instituted a solar year of 365 days 6 hours, which is now known under the name of the Julian year. To adjust this year to the annual revolution of the earth, which is six hours and some minutes more than 365 days, the length of the ordinary year, a day was appointed to be intercalated every fourth year in the month of February: this day, from its position in the Roman calendar, was called bissextile, a name which has also been given to the year in which the intercalation takes place.

The Julian year, although it approaches very near the truth, is not, however, perfectly correct. The true time of the annual revolution of the sun in the ecliptic is 365 days, 5 hours, and nearly 49 minutes, which falls short by a few minutes of the time assumed in the Julian year. How trifling soever this difference might at first appear, it amounted in a hundred and thirty-one years to a whole day: in consequence of this, the vernal equinox, which Sosigenes, in the first year of the Julian correction, observed to fall on the 25th of March, had gone back in A. D. 325, at the time of the council of Nice, to the 21st, and in A. D. 1582 to the 11th of March. To remedy this growing defect, Pope Gregory XIII. caused the calendar to undergo another correction. In A. D. 1580, he ordered ten days to be cut out of the month of October, so that the fourth was reckoned the 15th day: and to prevent such retrocession in future, in addition to the Julian regulation with respect to the bissextile year, he ordained that the years 1600, 2000, 2400, and every fourth century in succession should have an intercalation of a day, but that in the other centuries 1700, 1800, 1900, 2100, &c. the day should be omitted and those years remain common years. This regulation comes so near the truth that the only correction it will require will be the suppression of a day and a half in five thousand years.

The Gregorian year, or, as it is vulgarly called, the new style, was immediately adopted in Spain, Portugal, and part of Italy. It was introduced into France in October of the same year, the tenth of which month was, by an ordinance of Henry III. reckoned the twentieth day. In Germany it was adopted by the Catholic states in 1583, but the Protestant states adhered to the old calendar until the year 1700. Denmark also adopted it about this period, and Sweden in 1753. It was not used in England before 1752, when, by act of parliament, the style was changed, and the third of September was reckoned the fourteenth, the difference having by this time increased to eleven days. Russia is the only country in Europe in which the old mode of reckoning is still in use.

The want of some specific standard, which could be regarded as common to all nations, has occasioned great diversity in different countries in fixing the beginning of the year. The Chaldæans and Egyptians reckoned their years from the autumnal equinox. The Jews also reckoned their civil year from this period, but began their ecclesiastical year in the spring. Gemschid, the King of Persia, ordered the year in that country to commence at the vernal equinox. In Sweden the year formerly commenced at the winter solstice. The Greeks used different methods, some of the states beginning the year at the vernal, others at the autumnal equinox, and some at the summer solstice. The Roman year at one time began in March, but afterwards was made to commence in January. The new year's day of the Church of Rome is fixed on the Sunday nearest the full moon of the vernal equinox. In England the year began in March until A. D. 1752, when the act of parliament which altered the style ordained it to commence on the first of January.

Having thus given a short account of the

lunar and solar years, which have been mostly in use, and an acquaintance with which is of most consequence in chronology, it will be proper just to notice some combinations of years which are mentioned in ancient history, and therefore proper to be known.

Lustra. The Romans sometimes reckoned by lustra, a period of five years, which derived its name from a census instituted by Servius Tullius, which was to be paid by the Roman people every fifth year.

The Olympiads were, however, the most remarkable of these combinations. They consisted of four Grecian years, and derived their names from the public games celebrated every fourth year at Olympia, in Peloponnesus. These games were instituted in honour of Jupiter, but at what time, or by whom, is not known. After they had been neglected and discontinued for some time, they were restored by Iphitus, King of Elis, in the year B. C. 776; and it is from this date that the olympiads are reckoned in chronology.

Cycles are fixed intervals of time composed of the successive revolutions of a certain number of years. The lustra and the olympiads may perhaps be included under this name, but the term is more commonly appropriated to larger intervals, connected with the periodical return of certain circumstances and appearances. The great use made of cycles in chronology requires that they be particularly noticed.

From the defective nature of the Greek calendar, the olympic year, as it has been called, was subject to considerable variation; and, from the retrocession of the months, which it occasioned, producing a gradual change of the seasons when the games were to be celebrated, led to much inconvenience. Cleostrates, a mathematician of Tenedos, endeavoured to give it a more perfect form by inventing a cycle of eight years: this, however, being computed by lunar years, still left the calendar subject to great inaccuracies. To rectify these, Meton, a mathematician of great celebrity invented—

The Lunar Cycle, a period of nineteen solar years, at the end of which interval the sun and moon return to very nearly the same part of the heavens. This improvement was at the time received with universal approbation; but not being perfectly accurate, was afterwards corrected by Eudoxus, and subsequently by Calippus, whose improvements modern astronomers have adopted.

The use of this cycle was discontinued when the games, for the regulation of which it was composed, ceased to be celebrated. The Council of Nice, however, wishing to establish some method for adjusting the new and full moons to the course of the sun, with the view of determining the time of Easter, adopted it as the best adapted to answer the purpose: and from its great utility, they caused the numbers of it to be written on the calendar in golden letters, which has obtained for it the name of the golden number. The golden number for any year is found as follows:—The first year of the Christian æra corresponds to the second of this cycle; if then to a given year of this æra one be added, and the sum be divided by 19, the quotient will denote the number of cycles which have revolved since the commencement of the Christian æra, and the remainder will be the golden number for the given year. *e. g.* If the golden number of the present year (1808) be required, one being added, the sum will be 1809; this being divided by 19, will give 95 for the quotient and 4 for the remainder, or golden number sought.

The Solar Cycle is another of these periods, the inventor of which is at present, however, unknown. It consits of 28 years, at the expiration of which, the sun returns to the sign and degree of the ecliptic which he had occupied at the conclusion of the preceding period, and the days of the week correspond to the same days of the month as at that time. It is used to determine the Sunday, or dominical, letter, which we shall briefly explain.

In our present calendars the days of the week are distinguished by the first seven letters of the alphabet; A, B, C, D, E, F, G; and the rule for applying these letters, is invariably to put A for the first day of the year whatever it be, B for the second, and so in succession to the seventh. Should the first of January be Sunday, the dominical, or Sunday letter for that year will be A, the Monday letter B, &c. and as the number of the letters is the same as that of the days of the week, A will fall on every Sunday, B on every Monday, &c. throughout the year. Had the year consisted of 364 days, making an exact number of weeks, it is obvious that A would always have stood for the dominical letter: the year containing, however, one day more, it fol-

lows that the dominical letter of the succeeding year will be G. For Sunday being the first day of the preceding year will be also the last, and the first Sunday in the next year will fall on the seventh day, and will be marked by the seventh letter, or G. This retrocession of the letters will, from the same cause, continue every year, so as to make F the dominical letter of the third, &c. If every year were common, the process would continue regularly, and a cycle of seven years would suffice to restore the same letters to the same days as before. But the intercalation of a day every bissextile or fourth year, has occasioned a variation in this respect. The bissextile year containing 366, instead of 365 days, will throw the dominical letter of the following year back two letters; so that, as in the present year (1808), if the dominical letter at the beginning of the year be C, the dominical letter of the next year will be, not B, but A. This alteration is not effected by dropping a letter altogether, but by changing the dominical letter at the end of February, where the intercalation of a day takes place. Thus, in the present year, C is the dominical letter in January and February, but B is substituted for it in March, and continues to be the dominical letter through the remainder of the year. In consequence of this change every fourth year, twenty-eight years must elapse before a complete revolution can take place in the dominical letter, and it is on this circumstance, that the period of the solar cycle is founded. A table constructed to shew the dominical letters for any given years of one of these cycles, will answer for the corresponding years in every successive cycle. The first year of the Christian æra corresponds to the ninth of this cycle: if, therefore, to any given year of the Christian æra nine be added, and the sum be divided by 28, the quotient will denote the number of the revolutions of the cycle since the ninth year B. C. and the remainder will be the year of the cycle. If there be no remainder, the year of the cycle will be the last, or twenty-eight. *e. g.* Nine being added to 1808, makes 1817; this sum being divided by 28, gives a quotient of 64 for the revolutions of the cycle, and a remainder of 25 for the year of the cycle. There is another cycle in use called,

The Cycle of Indiction. It consists of fifteen years, and is derived from the Romans. Learned men are not agreed as to the origin of it, but the most probable opinion is, that the return of this period was appointed for the payment of some public taxes or tributes. The first year of this cycle is made to correspond to the year 3 B. C. If therefore to any given year of the Christian æra 3 be added, and the sum be divided by 15, the remainder will be the year of this cycle. There is however another mode of calculating it. This cycle was established by Constantine A. D. 312; if therefore from the given year of the Christian æra 312 be subtracted, and the remainder be divided by 15, the year of this cycle will be obtained. In either of these ways, if there be no remainder, the indiction will be 15. We subjoin an example calculated by each of the methods above specified.

```
        1808                              1808
           3                               312
15 )    1811 (120                  15 )   1496 (99
          15                               135
          31                               146
          30                               135
          11 { the indiction for the        11
               present year.
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The Julian Period, some acquaintance with which is indispensable in the study of chronology, will be easily understood from the preceding account of the cycles. It is formed by the combination of the three, by multiplying the numbers 28, 19, and 15, of the cycles of the sun, moon, and indiction, into each other. The total of years thus produced, is 7980, of which the Julian period consists, at the expiration of which, and not sooner, the first years of each of those cycles will again come together. This period was invented by Joseph Scaliger, as one by which all æras, epochs, and computations of time might readily be adjusted. The first year of the Christian æra corresponds to the 4714th of the Julian period, and it extends as far back as 706 years beyond the common date of the creation 4004. The year of the Julian period corresponding with any given year before or since the commencement of the Christian æra, may easily be found by the following rule. If the year required be of the latter kind, add to it 4713, the number of years of the Julian period elapsed before the Christian æra, and the sum will be the year required. If it be of the former, subtract the year B. C. from 4714, and the difference will give it.

This period has been esteemed by many

to be of the highest importance in chronology, as affording a common standard for the adjustment of different epochs. Modern chronologers are not however so warm in their admiration of it as their predecessors have been. A common standard is unquestionably of the highest consequence in the comparison of dates and æras, and in the general arrangement and division of time, and from its great utility and the necessity of its frequent application, it is of importance that it should be as simple as possible in its nature and construction. The Julian period is liable to objection on the latter score, as being rather complicated in its formation; and its necessity is now altogether superseded by the very general adoption of the Christian æra as the standard of time. Any events or æras, prior or subsequent to its commencement, may easily be computed by it, and the date of them be impressed in the memory with very little exertion or difficulty.

It remains that we give some account of *Epochs and Æras*, terms which constantly recur in history, and the elucidation of which belongs to the province of chronology. An epoch is a certain point, generally determined by some remarkable event, from which time is reckoned; and the years computed from that period are denominated an æra. The birth of Christ is considered as an epoch—the years reckoned from that event are called the Christian æra.

In sacred chronology the first and most remarkable epoch is that of the creation of the world. As learned men could not agree as to the precise time when this took place, the folly of reckoning from it as a standard soon became apparent, and the practice was in consequence abandoned. Archbishop Usher, whose scripture chronology is adopted in our English Bibles, fixes this event in the year 4004, before Christ, Playfair places it in 4007.

The universal deluge forms another epoch, this is placed by Usher in the year B. C. 2349. A third sacred epoch is the call of Abraham, which happened according to the same learned authority B. C. 1921. The next epoch is the departure of the Israelites from Egypt, which Usher places B. C. 1491.

In profane history we shall first notice the epoch of the Argonautic expedition, an event much celebrated in ancient history, and of some importance in chronological discussion, from being adopted by Sir Isaac Newton as the foundation of his system of chronology. The date of this transaction has been placed in the year 1225 B. C. but in this chronologers are not agreed.

The destruction of Troy forms another remarkable epoch. Considerable uncertainty prevails as to the exact time when this event, as well as the preceding, took place. Playfair fixes it in the year B. C. 1184.

The æra of the Olympiads we have noticed above, and it will be unnecessary to give any farther account of it here. The epoch of the building of Rome is the next that claims our attention. From the total want of early records, and other necessary documents for deciding the question, the date of this event is involved in the obscurity common to many other remote occurrences. The Roman writers themselves, and all who have followed them on the subject, differ widely respecting it. Polybius fixes it in the year B. C. 751. Cato, and others, one year earlier. Terentius Varro places it in 753 B. C. Fabius Pictor, who is followed by Diodorus Siculus, assigns it to 747 B. C. Sir Isaac Newton adopts the year 627 B. C. and Playfair after Varro, whose computation was used by the Roman Emperors in their public instruments, places it in the year B. C. 753. Great use is made of this epoch in the histories of ancient Rome, and the historical student will do well to ascertain, if possible, what opinion the author he may be perusing adopts, and to what year of the Christian æra the first year of Rome, according to his author, corresponds. The dates of the events will by this method be accurately ascertained as he proceeds. The Romans sometimes reckoned the year from the establishment of the consular dignity, and afterwards from the years of the Emperors.

The æra of Nabonassar is another of those standards by which the dates of events in some histories are regulated. Nabonassar was the founder of the Babylonish monarchy. This æra is reckoned from the commencement of his reign, which is placed in the year B. C. 747, of the Julian period 3967, and extends as far down as the death of Alexander. The Nabonassarean year consists of 12 months of 30 days each, and five intercalary days, making in all 365 days.

The æra of the Seleucidæ, or, as it is sometimes called, the year of the contracts, is reckoned from the establishment of Seleucus, one of Alexander's generals, after that conqueror's death, in the empire of Baby-

lon, and is reckoned from the year B. C. 312. It is generally supposed to have begun in the spring. It was used in a large district of Asia, and adopted by the Jews.

The Spanish æra, founded on a division of the Roman provinces among the Triumviri, was long in use in Spain and Africa, and was adopted in the dates of the principal councils and synods held in those countries. It is reckoned from the first of January B. C. 38. This was afterwards superseded by

The Christian æra. Learned men have differed in opinion with respect to the exact time of the birth of Christ, some placing it four, others seven, years earlier than the first year of the Christian æra. The uncertainty which exists upon this point arises from the æra not having been used until so many centuries had elapsed, that it was impossible to fix the date with accuracy. This is, however, of very little consequence in the application of this æra to chronological purposes, for all are agreed as to the numerical date of every year, the year 1808 for instance being universally received as the year 1808 of the Christian æra, although probably not the exact measure of the time which has elapsed from the birth of Christ. This æra was invented about the year 527 by Dionysius, a Roman abbot, who reckoned the first year of it to correspond with the 4714th of the Julian period. It may be useful to give the reader a view of the years of the other principal æras which correspond to the first of this: according to Playfair, (who, it is to be observed, differs in many respects from other chronologers, but is nevertheless a most respectable authority) these are the 4008th year of the world, the first year of the 195th Olympiad, the 754th year of Rome, the 749th of the Nabonassarean æra, the 313th of the Seleucidæ, the 46th Julian year, and the 39th of the Spanish æra.

The æra of Dioclesian was used pretty generally by the Christians previous to the invention of the Christian æra. It is dated from the year A. D. 284, and probably took its rise from the persecution under that Emperor, although its date is computed from the first year of his reign.

The Hegira, which may be called the Mohammedan æra, is founded upon the flight of Mohammed from Mecca to Medina, to escape the persecution of his enemies, and is computed by his followers from A. D. 622. The beginning of their year is however made to correspond with the 16th day of July. In comparing any year of this æra, therefore, with the corresponding year of the Christian æra, it will be necessary to bear this in mind before it can be done with accuracy. The same may also be observed with regard to some of the other æras, the beginnings of the years of which do not exactly correspond with that of the Julian year.

The Persian æra, or the æra of Yezdejerd, is the last we shall notice. Yezdejerd was the last of the Persian monarchs who was subdued by the Saracens. According to the opinion of the most reputable modern chronologers, this æra commenced in June A. D. 632, corresponding with the beginning of the eleventh year of the Hegira, and with the first year of the reign of Yezdejerd. The years of this æra, like the Nabonassarean, consist of 12 months of 30 days, with an addition of 5 intercalary days at the end, making in all 365 days.

The limits of our plan will not allow us to enter more minutely into the details of this important science. For these we must refer to separate treatises on the subject. The abstract which is here given will, however, be found sufficient for all the general purposes of the historical student. We have purposely refrained from giving a chronological table of remarkable events, as such tables are to be procured with very little trouble. Various ingenious methods have been invented of associating the name of some remarkable event with the date of its occurrence, with the view of impressing it on the memory; for some account of these we must refer to the article MEMORY, ARTIFICIAL.

CHRONOMETER, an instrument or machine for measuring time. The word is more particularly used by workmen and navigators to denote a watch or portable machine, in which, by the nature of the escapement and the compensations for heat and cold, mean time is or ought to be kept with sufficient accuracy to determine the longitude at sea.

The relation between time and longitude will be fully explained hereafter: it will therefore be sufficient in this place to remind the reader, that the rotation of the earth upon its axis brings the several places upon its surface, in succession, opposite the sun, causing day and night; so that the absolute instant of noon or of any other determinate apparent time of the day at each place must be earlier, at a place which lies to the eastward of another, with which that place may be compared. From this

general fact it follows that, allowing 24 hours for the whole rotation of the earth, and proportionally for every smaller part of the rotation, we may determine (provided the apparent time at two places be known) what is the difference of longitude between them. Thus, if a chronometer set to the time at Greenwich, were to be carried to Petersburgh, in Russia, it would indicate time two hours later than the clocks at Greenwich; that is to say, it would shew when it was noon at Greenwich, instead of when at Petersburgh. The obvious conclusion would be, that the sun arrives at the meridian of Petersburgh earlier, and consequently that this town lies mere easterly than Greenwich; and as 2 hours are in proportion to 24 hours, so is 360°, the earth's circumference, to 30°, the longitude of St. Petersburgh, reckoned from Greenwich. Upon the same principle it is that the clocks in a large town ought not to indicate the same time. Thus the clocks at St. Paul's, St. Clement's, St. Martin's, and St. George's, Hanover Square, in London, ought to strike each four seconds after the other; and this difference, it may be added, would nearly vanish, if heard from any of the westerly stations; on account of the time employed for the passage of sound; and for the same reason it would be nearly doubled in the opposite direction.

From the intimate relation which subsists between the construction of watches and clocks, the similitude of the escapements, and the common principles upon which the compensations for heat and cold are effected in each, we shall explain the principles of each under the general article HOROLOGY; and at present we shall only give an account of the nature of the expedients adopted to produce superior accuracy in these portable machines.

The train of wheels, which constitutes so large a part of every time-piece, must necessarily transmit the force of the first mover with periodical irregularities arising from oblique actions of their teeth upon each other; and these irregularities will be subject to other variations arising from the greater or less degree of fluidity in the oil applied to the pivots and elsewhere. The first mover also in a portable machine being a spring will be more rigid and consequently act with greater power when cold than when hot. The balance, or vibrating measurer of the time, is a wheel, or equivalent piece, fixed on an axis, upon which it could freely turn; but this liberty is restrained by a fine spring called the pendulum spring, which is fastened to the axis, and after taking several turns round without touching it, the other end of the spring is fixed to the frame of the machine. By this contrivance the balance will, if not prevented, come to rest in one particular position; and if, at any time disturbed, it will only vibrate each way from the line of quiescence, performing larger or smaller arcs according to the disturbing force. This force in a watch or time-keeper is communicated from the train; most commonly during the time of each vibration: and the machinery or contrivance by or through which the successive impulses, or actions, are made, is called a scapement or ESCAPEMENT, several of which are described at the articles referred to.

According to the nature of the escapement and the part of the vibrating arc at which the impulses are applied, the vibrations of the balance may be made to employ a longer or shorter time than they would have employed if the balance had been separate from the works. Thus, in the common watch, these impulses quicken the vibrations; and consequently an increase in the maintaining force will make the watch go faster; as may be easily tried by gently forcing the key in the opposite direction to winding up.

If the balance and its spring were to continue unchanged in all temperatures and under all circumstances, and if its long and short vibrations measured equal times when separate from the machine, it would only be required that the escapement should be so constructed as neither to accelerate nor retard them. But none of these conditions can be had in the ordinary structure of watches, and in the superior timepieces considerable difficulties are found in the attempt to obtain them.

By the natural contraction, to which all bodies are subject when cooled, the diameter of the balance will be less the lower the temperature: it will therefore be more easily carried by the vibrating forces, and will then vibrate more quickly.

The spring attached to the balance, which is called the pendulum spring, will likewise act with greater force when cold, and on this account also the vibrations will be quicker.

The remedies for these causes of imperfection are the following:

1. The Remontoire. As the irregularities

in the transmission of force from the main spring are certainly increased by the number of wheels in the train, it was proposed, in the infancy of the art, to detach the last wheel, or that nearest the balance, or time measurer, from the rest, and to move this by a separate spring or weight: so that in this contrivance the time measurer is acted upon by one single wheel, and the rest of the train is employed in winding up the secondary first mover at short intervals, such, for example, as every half minute. We shall also have to mention some escapements in which the winding up is performed in every single vibration. With regard to remontoires it may be remarked that they either greatly shorten, or else destroy the periodical irregularities of the train, and those of the main-spring; but that with regard to the influence of oil and other causes of more permanent difference their advantage is not very considerable, because the remedy is not applied where the motion is quickest.

Whether the irregular action of the maintaining power be diminished by the remontoire or not, it is desirable that the impulse on the balance, through the escapement, should affect the natural measure of its vibrations as little as possible; or rather that it should tend to equalise them when the arcs of vibration vary. Some attention, but not much, has been paid to the equalising quality of an escapement, principally by making the faces of the pallets of a figure suitable to that effect; but these are now for the most part abandoned, and the method of applying the force constitutes the distinguishing feature in this part of our modern chronometers. If a balance be set to vibrate by the mere action of its pendulum-spring, its motion will soon decay; but if we suppose a lever or pallet to proceed from its axis, and a maintaining power to be applied to this, it is obvious that if the power meet the pallet in its progress from the point of quiescence it will shorten the time, and also the arc of that semi-vibration; and, again, that if the power follow the pallet in its progress towards the point of quiescence, it will drive it home sooner, and consequently will shorten the time of that semi-vibration; and that actions contrary to these would lengthen the times. If, therefore, the action itself, which may be considered as an accellerating force, be not applied on both sides of the point of quiescence through a certain arc, determinable from the circumstances, the maintaining power when it comes to be applied will alter the time; and if this vary, the time must also vary. Now the remedy at present adopted is to make the balance vibrate through a very large arc, such as a semicircle or more, and to follow the pallet in each returning vibration by a strong power exerted through a very small arc, as, for example, 15° or 16°. By this contrivance the balance will vibrate at perfect liberty, out and home, through two semicircles, or 360°, excepting the small part during which the impulse is given; and if the impulse vary, the arc of vibration will vary, and with it the time, unless the spring be made of a certain definite length, or tapered in its thickness according to the experience which many artists in this country possess.

The escapement generally used in our best chronometers, as we shall hereafter see, consists of a toothed wheel at the end of the train, which is prevented from running down by a detent or hook, and of two pallets, a longer and a shorter, fixed upon the verge or axis of the balance. These pallets are so placed, that when the face of the longer pallet has just arrived before one of the teeth of the wheel, the shorter pallet strikes out the hook, and allows the wheel to push forward the longer pallet with its tooth, during which action, the hook falls again into its place to catch the succeeding tooth. The balance therefore proceeds in its vibration, and returns again without disturbing the train; because the short pallet does not strike out the hook in its backward course, but only acts on a slender spring, resembling those formerly used in the jacks of harpsichords. In this manner the vibrations are kept up; and so little do the variations in the maintaining power affect the rate, when all the adjustments are made, that if the main-spring be let down to only a small part of its ordinary tension, these time-pieces will keep the same rate for many hours together.

However perfect, practically speaking, the application of the maintaining power may be, yet if the balance and its spring be subject to vicissitudes from heat and cold it will be in vain to expect accuracy. There are two ways of correcting this compound time-measurer. The first, which was invented by Peter Leroy, consists in causing the balance to enlarge itself, instead of contracting by heat; by which means the spring, when in the state of greater rigidity has more work to do; and the other

acts by lengthening or shortening the spring when cold or heat may have given it more or less of force. This was invented by Harrison, and depends on the well-known fact that a short spring is stiffer than a longer; so that by shortening his spring at the time when it was weakened by heat and the balance enlarged by the same cause, he gave it the stiffness requisite to compensate for these alterations; and the same contrivance produced the contrary effect in cold temperatures. As we shall more fully exhibit these inventions under the article HOROLOGY, it is only necessary to observe that Peter Leroy constructed his first time piece with fluid thermometers on the balance, and that he also invented our present expansion balance of brass and steel, soldered or fused together in the rim, which was afterwards introduced and brought to great perfection by Arnold.

Machines, made upon the principles here cursorily pointed out, have measured time to a wonderful degree of perfection; and from the immense maritime trade of the British empire, and the scientific disposition of many wealthy individuals, the demand has been so great as to have produced a very great number of able workmen fully equal to their construction, at the same time that the prices have been considerably reduced. Most sea commanders of any respectability are provided with two or more of them.

Among the other causes of irregularity in time measurers, the resistance of the air has been occasionally considered by authors. But artists seem to suppose, either that it is a constant quantity, or that its variations are not considerable enough to be brought into the account. The very accurate performance of some chronometers, and the steady going of astronomical clocks seem to give weight to this supposition; but on the other hand it may be remarked that though the slow motion of heavy pendulums vibrating through small arcs in astronomical clocks, must be subject to very little resistance indeed from the air, yet it does not follow that the rapid vibrations of a balance may not be affected by this cause; and the extreme precision of some chronometers will not, perhaps, be admitted as a very strong argument, when we consider that the changes from barometrical causes may have compensated each other, and that the most perfect machines will vary as much as one second per day, from causes which have not been yet clearly detected, though these are probably resolvable into that before us. We are more particularly led to these reflections by a communication from Mr. Manton, of Davies-street, who found by experiment that a chronometer, which was going upon a gaining rate of five seconds per day, did increase its arc of vibration by an additional 50 degrees immediately upon the air being exhausted, and that being kept in vacuo, its rate became 37 seconds per day, the gain being 34 seconds upon the former rate. Hence it follows, that as the difference between the highest and the lowest stations of the barometer indicate a change of about one-fourteenth part in the density of the air, the correspondent change per day, in the rate, may be two seconds and a half, or about one second per inch. Hence it may happen that a capital time-keeper shall indicate a more steady rate from week to week than from day to day.

The causes of imperfection in chronometers, which still call for farther exertions of sagacity in our artists, are 1. The spring gradually tires or falls off from its strength, and neither the law of this variation nor its remedy are known. The effects of this change are, that all the adjustments are disturbed by it. 2. There is great reason to apprehend that the expansion-bars of brass and steel do change in their relative powers of flexture by their continued action on each other, though it is probable they settle at last. 3. The wear of the acting parts is uncertain, and will affect the time of striking out the detent and the arc of impulse. 4. No certain rules have been given, or are perhaps known, for making all the vibrations equal in time. If we suppose the long and short vibrations to be at first adjustable, with certainty, to equal times, not only for the extremes but for all the means or intermediate arcs, it will not follow that the falling off from wear or from tiring, or from change in the balance, will continue to be accompanied by the same isochronism. 5. The best artists find very great difficulty in adjusting a pocket chronometer for all positions, preserving at the same time the other needful adjustments. See ESCAPEMENT, HOROLOGY, PENDULUM, TRAIN, and the articles thence referred.

CHRYSALIS, in natural history, a state of rest and seeming insensibility which butterflies, moths, and several other kinds of insects, must pass through before they arrive at their winged or most perfect state.

The first state of these animals is in the caterpillar or reptile form; then they pass into the chrysalis-state, wherein they remain, immoveably fixed to one spot, and surrounded with a case or covering, which is generally of a conical figure; and, lastly, after spending the usual time in this middle state, they throw off the external case wherein they lay imprisoned, and appear in their most perfect and winged form of butterflies, or flies. See CATERPILLAR.

CHRYSANTHEMUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Dioscoideæ. Corymbiferæ, Jussieu. Calyx hemispherical, imbricated; the marginal scales membranaceous; pappus margined; receptacle naked. There are twenty-seven species.

CHRYSIS, *golden fly*, in natural history, a genus of insects of the order Hymenoptera. Mouth horny, projecting; lip much longer than the jaw, which is linear, membranaceous, and emarginate at the tip: no tongue; feelers four, unequal filiform; antennæ short, filiform, of twelve articulations, the first longer; body gilt polished; abdomen arched beneath, with a scale on each side; tail generally toothed; sting pungent, nearly concealed; wings flat. These are generally found in the holes of old walls. There are more than thirty species.

CHRYSITRIX, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: hermaphrodite; glume bivalve; corolla of numerous setaceous chaffs; stamina many, solitary, between the chaffs; pistil one: male as in the hermaphrodite; pistil one. There is but one species; *viz.* C. capensis, a perennial plant; native of the Cape of Good Hope.

CHRYSOBALANUS, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; style lateral; drupe with a five-furrowed, five-valved nut. There is but one species; *viz.* C. icaco, cocoa plumb, a shrub about eight feet high. Native of the Caribbee islands, and the neighbouring continent near the sea.

CHRYSOBERYLL, in mineralogy, a species of the flint genus. Its chief colour is asparagus green, passing on the one side into an apple-green, mountain green, and greenish white; on the other side it passes through light olive and oil green into yellowish grey, which inclines to brown. It occurs but seldom crystallized, and then the crystals are small, externally shining, internally splendent, and intermediate between the resinous and vitreous. It is brittle, not easily frangible; specific gravity from 3.6 to 3.8. Before the blow-pipe it is infusible without addition: it is found in Brazil, in the sands of Ceylon, along with rubies and sapphires: it is sometimes cut for ring-stones, and is usually set with yellow foil, but is seldom to be met with even in the possession of jewellers: it is called the Oriental chrysolith, in commerce: constituent parts

Alumina	71.5
Silica	18.0
Lime	6.0
Oxide of iron	1.5
Loss	3.0
	100.

CHRYSOCOMA, in botany, English *goldy locks*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx hemispherical, imbricate; style scarcely longer than the florets; pappus simple; receptacle naked. There are thirteen species; almost all of them natives of the Cape of Good Hope.

CHRYSOGONUM, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx five-leaved; seeds involved in a four-leaved calycle; pappus one-leafed, three-toothed; receptacle chaffy. There is but one species; *viz.* C. virginianum, a native of Virginia.

CHRYSOLITE, in mineralogy, a species of the flint genus; the chief colour of which is pistachio green, of all degrees of intensity: it occurs sometimes in original, angular, pretty sharp-edged pieces, which are frequently notched, and exhibit a peculiar, rough, scaly, splintery surface; also in rolled pieces, and crystallized; brittle; easily frangible; specific gravity about 3.4; infusible before the blow-pipe without addition; constituent parts according to Klaproth.

Silica	38.0
Magnesia	39.5
Oxide of iron	19.0
Loss	3.5
	100.0

It is found principally in Upper Egypt; but has been met with in Bohemia, and in the isle of Bourbon. It is employed as a precious stone in different kinds of jewelry, but of no very great value. Werner thinks that the stone described by the ancients under the name of yellow chrysolite, answers to our topaz.

CHRYSOMELA, in natural history, a genus of insects of the order Coleoptera. Antennæ moniliform; six feelers, growing larger towards the end; thorax marginate; shells immarginate; body mostly oval. Of this genus there are several hundred species. they are separated into three distinct divisions. A. lip entire; hind legs equal. B. oblong; lip bifid; hind thighs equal. C. oblong; lip bifid; hind thighs thickened. This numerous and very beautiful tribe is found every where in woods and gardens. Their motion is slow, and some of them when caught emit an oily liquor of a disagreeable smell. The larvæ of this genus, and also of the Cryptocephalus, feed on the leaves of trees and plants.

CHRYSOPHRAS, in mineralogy, a species of the Flint genus, of an apple-green, of all degrees of intensity, passing through the various shades of greenish grey. It is found massive in angular pieces, and thick plates. Internally it is dull; some rare varieties are glimmering. Specific gravity 3.25. Before the blow-pipe it loses its colour and transparency, and is infusible without some addition. By analysis it is found to contain

Silica	96.16
Lime	0.83
Oxide of nickel	1.00
	97.99

A trace of alumina and oxide of iron. It is found with quartz, opal, chalcedony, &c. in serpentine, in Lower Silesia. It is chiefly used for ring-stones; but is difficult to cut and polish. The apple-green variety is the most highly valued, and ring-stones of that colour will fetch 10. or 12*l*. It passes into horn-stone and chalcedony, and into a fossil which is intermediate between chrysophras and opal. It loses much of its colour when kept in a warm and dry place, or when much exposed to the air. Very elegant specimens of this beautiful fossil are to be seen in the great cathedral at Prague, where a closet is inlaid with it.

CHRYSOPHYLLUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: corolla bell-shaped, ten-cleft; segments alternate, spreading; berry ten-seeded. There are six species; natives of the West Indies.

CHRYSOSPLENIUM, in botany, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Essential character: calyx four or five-cleft, coloured; corolla none; capsule two-beaked, one-celled, many-seeded. There are two species; *viz.* C. alternifolium, alternate-leaved golden saxifrage; and C. oppositifolium, opposite-leaved golden saxifrage. These plants are found in moist shady places, by the sides of rivulets in Lapland, Sweden, Denmark, Germany, Switzerland, and with us, about Norwich and Worcestershire.

CHURCH, has different significations, according to the different subjects to which it is applied. 1. It is understood of the collective body of Christians, or all those over the face of the whole earth who profess to believe in Christ, and acknowledge him to be the Saviour of mankind. This is what the ancient writers call the catholic or universal church. 2. Church is applied to any particular congregations of Christians, who at one time, and in one place, associate together and concur in the participation of all the institutions of Jesus Christ, with their proper pastors and ministers. Thus we read of the church of Antioch, the church of Alexandria, the church of Thessalonica, and the like. 3. Church denotes a particular sect of Christians, distinguished by particular doctrines and ceremonies. In this sense we speak of the Romish church, the Greek church, the Reformed church, the church of England, &c.

The Latin or Western church comprehends all the churches of Italy, France, Spain, Africa, the North, and all other countries whither the Romans carried their language. Great Britain, part of the Netherlands, of Germany, and of the North, have been separated from hence ever since the time of Henry VIII. and constitute what we call the Reformed church, and what the Romanists call the Western Schism. The Greek or Eastern church, comprehends the churches of all the countries anciently subject to the Greek or Eastern empire, and through which their language was carried; that is, all the space extended from Greece to Mesopotamia and Persia, and thence into Egypt.

CHURCH, the place which Christians consecrate to the worship of God. By the

common law and general custom of the realm, it was lawful for earls, barons, and others of the laity, to build churches; but they could not erect a spiritual body politic to continue in succession, and capable of endowment, without the king's license; and, before the law shall take knowledge of them as such, they must also have the bishop's leave and consent, to be consecrated or dedicated by him.

CHURCHWARDENS, the guardians or keepers of the church, are persons annually chosen in Easter week, by the joint consent of the minister and parishioners, or according to the custom of the respective places; to look after the church and church-yard, and things thereunto belonging. They are entrusted with the care and management of the goods and personal property of the church, which they are to order for the best advantage of the parishioners; but they have no interest in, or power over the freehold of the church itself, or of any land or other real property belonging to it; these are the property of the parson or vicar, who alone is interested in their loss or preservation. The churchwardens therefore, may purchase goods and other articles for the use of the parish; they may likewise, with the assent of the parishioners, sell or otherwise dispose of the goods of the church; but without such consent, they are not authorised to alienate any of the property under their care.

All peers of the realm, clergymen, counsellors, attorneys, clerks in court, physicians, surgeons, and apothecaries, are exempt from serving the office of churchwarden, as is every licenced dissenting teacher, pretending to holy orders.

CHURN, an implement for agitating cream or milk, so as to separate the butyrous particles from the serous, and to effect the production of butter. Some churns are made upright, of a tapering form, and are worked by means of a pole and cross: the former passing through a hole in the lid. These are pail or bell-churns. Many churns are in the form of a barrel; in some of these beaters, or projecting battens, are affixed within four or five of the staves, which strike the cream as the barrel is moved round by means of a winch; in others, the barrels are at rest, while a cross fly, of four or more leaves, it turned within it: in either case, the barrel is supported on a frame. The Indian churn has an alternate motion, being worked by a vertical pole, which is turned much the same as a hand-lathe; having its lower part split, the pole occasions great agitation in the cream. A great variety of churns are in use; but, in general their formation evinces more ingenuity than practical knowledge. Those moved by pedals, and of which, as well as of the Indian churn, an accurate description is given in the Agricultural Magazine for October, 1807, merit particular attention for their great simplicity and many good qualities.

CHYLE. See CHYME, ASSIMILATION, &c.

CHYME, in animal economy: in the process of digestion, the food is subjected to a temperature usually above 90° of Fahrenheit; it is mixed with the gastric juice, a liquor secreted by the glands of the stomach, and is made to undergo a moderate and alternate pressure, by the contraction of the stomach itself. It is thus converted into a soft uniform mass of a greyish colour, in which the previous texture, or nature of the aliment can be no longer distinguished.

The chyme, as this pulpy mass into which the food in the stomach is resolved is termed, passes by the pylorus into the intestinal canal, where it is mixed with the pancreatic juice and the bile, and is still exposed to the same temperature and alternating pressure. The thinner parts of it are absorbed by the slender tubes termed the lacteals. The liquor thus absorbed is of a white colour; it passes through the glands of the mesentery, and is at length conveyed by the thoracic duct into the blood. This part of the process is termed chylification, and the white liquor thus formed, chyle. It is an opaque milky fluid, mild to the taste. By standing for some time, one part of it coagulates; another portion is coagulated by heat.

The chyle, after mixing with the lymph conveyed by the absorbent vessels, is received into the blood which has returned from the extreme vessels, and before it passes to the heart. All traces of it are very soon lost in the blood, as it mixes perfectly with that fluid. It is probable, however, that its nature is not immediately completely altered. The blood passing from the heart is conveyed to the lungs, where it circulates over a very extensive surface presented to the atmospheric air, with the intervention of a very thin membrane, which does not prevent their mutual action. During this circulation, the blood loses a considerable quantity of carbon, part of which, it is probable, is derived from the imperfectly assimilated chyle

as this, originating in part from vegetable matter, must contain carbon in larger proportion than even the blood itself. See ASSIMILATION.

CICADA, in natural history, a genus of insects of the order Hemiptera. Generic character: snout inflected; antennæ setaceous; the four wings membranaceous and deflected; legs in most of the species formed for leaping. These insects live on various plants; the larva is apterous; the pupa furnished with the mere rudiments of wings; both of them six footed and active. The male of the perfect insect chirps like the cricket. There are some hundred species noticed and described by different authors, and enumerated with their characters by Gmelin. There are three divisions.—A. antennæ subulate, inserted in the front. B. legs not formed for leaping. C. antennæ filiform, inserted under the eyes; this class is subdivided into, 1. *a.* lip abbreviated, truncate, emarginate; and, 2. *b.* lip rounded, setaceous at the tip. The most common of the European species is C. flebeia, which has been long confounded with the grasshopper. It is a native of the warmer parts of Europe, appearing in the hotter months, and continuing its chirping during the greater part of the day, generally sitting among the leaves of trees. The insects proceed from eggs deposited by the parent in and about the roots of trees, near the ground. They hatch into larva, in which state they continue nearly two years, cast their skins, and produce the complete insect. The male cicada alone makes the chirping, the female being entirely mute: the noise of the former proceeds from a pair of concave membranes, seated on each side the first joint of the abdomen: the large concavities of the abdomen, immediately under the two broad lamellæ in the male insect, are also faced by a thin pellucid, irridescent membrane, serving to increase and to reverberate the sound, and a strong muscular apparatus is exerted for the purpose of moving the necessary organs. Among the smaller European species is C. spumaria, or cuckow-spit cicada, so named from the circumstance of its larva being found constantly enveloped in a mass of white froth adhering to the leaves and stems of vegetables. This froth, which is popularly known by the name of cuckow-spittle, is found in the summer, and is the production of the included larva, which, from the time of its hatching from the egg deposited by the parent insect, continues, at intervals, to suck the juices of the stem on which it resides, and to discharge them from the vent in the form of very minute bubbles; and by continuing the operation, completely covers itself with a large mass of froth, which is sometimes so overcharged with moisture, that a drop may be seen hanging from its under surface.

CICCA, in botany, a genus of the Monoecia Tetrandria class and order. Essential character: male, calyx four-leaved; corolla none: female, calyx three-leaved; corolla none; styles four; capsule tetracoccous. There is but one species, *viz.* C. disticha, a native of the East Indies.

CICER, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-parted, length of the corolla; the four upper segments incumbent on the banner; legume rhombed, turged, two-seeded. There is but one species, *viz.* C. arietinum, chich pea, which is an annual, and a native of the South of Europe, the Levant, and Africa, where it is frequently eaten, both raw and boiled.

CICHORIUM, in botany, English *succory*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cinaracephalæ, Jussieu. Essential character: calyx calycled; pappus slightly five-toothed, obscurely hairy; receptacle somewhat chaffy. There are three species: the first of which, C. intybus, wild succory, is generally considered as a common weed; it is, however, cultivated as food for cattle; C. endivia, broad-leaved succory, or common endive, is cultivated in our English gardens, being one of the principal ingredients in our autumn and winter salads. C. spinosum, prickly succory, grows naturally on the sea coast in Sicily, and the islands of the Archipelago.

CICINDELA, in natural history, a genus of insects of the order Coleoptera: antennæ setaceous: feelers six, filiform; the hind ones hairy: mandible prominent, armed with many teeth: eyes prominent: thorax rounded, margined, narrower than the head. There are about 60 species, in two divisions. A. lip three-toothed. B. lip rounded, pointed entire. The cicindela is in general a very beautiful genus of insects: they are found in dry sandy places, and prey with the most ravenous ferocity upon all other insects which come in their way, and which they can overcome: the larva is soft, white, long, six-footed, with a brown scaly head, and lurks in a round perpendicular hole in the ground, with its head at

the entrance, to draw in and devour whatever insects may come near or fall into it. These insects are remarkable for the celerity and vigour of their flight: they are generally seen on the wing in the hottest part of the day, chiefly frequenting dry meadows, &c. C. campestris, one of the most common European species, is a highly beautiful insect, being of a bright grass green, with the wing-shells each marked by five small, round, white spots; the head, thorax, and limbs are of a rich gilded cast, and the eyes black and prominent; the legs are long and slender: it is common in the fields, and is about half an inch long.

CICUTA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit subovate, furrowed. There are three species, of which C. virosa, long-leaved water hemlock, generally grows near the sides of large stagnant waters, or in shallow slow rivers. Towards the end of autumn, the root for the succeeding summer is formed out of the lower part of the stalk: this is divided transversely into many large unequal cells; so that it becomes specifically lighter than water, and in winter, when the rivers or pools swell, is buoyed up. It is an inhabitant of the northern parts of Europe, and is one of the rankest of vegetable poisons.

CIENFUEGIA, in botany, a genus of the Monadelphia Dodecandria class and order. Calyx double, the outer of 12 setaceous leaves; petals five; style filiform; stigma clavate; capsule three-celled, three seeds. A single species, found in Senegal.

CIMEX, in natural history, the *bug*, a genus of insects of the order Hemiptera. Snout inflected; antennæ longer than the thorax; wings four, folded crosswise; the upper ones coriaceous on the upper part; back flat; thorax margined; legs formed for running. Of this genus more than a thousand species have been enumerated and described. The divisions are, 1. A. antennæ inserted before the eyes: which is subdivided into, *a.* without a lip: *b.* lip long, subulate, annulate: *c.* lip short, rounded; body long, linear: *d.* sheath four-jointed, the first membranaceous; body long and narrow. B. Antennæ inserted above the eyes. Of this very extensive genus only the C. lectuarius, or common bed bug, is apterous, or without wings. It is said not to have been known in England before the year 1670, when it was imported among timber used in rebuilding the city of London after the great fire in 1666. The bug is one of the best subjects for exhibiting a microscopic view of the circulation of the blood. See BUG.

CIMICIFUGA, in botany, a genus of the Polyandria Tetragynia class and order. Natural order of Multisiliquæ. Papaveraceæ, Jussieu. Essential character: calyx four or five-leaved; nectary four, urceolate; capsule four to seven. There is but one species; *viz.* C. fœtida, a native of the distant parts of Siberia; flowering in July, and ripening its seed in August. The whole plant has a strong virose smell, occasioning the head-ach.

CIMOLITE, in mineralogy, is of a light greyish white, inclining to pearl-grey; but by exposure to the air it acquires a reddish tint. It occurs in mass, forming large strata; its fracture is earthy, uneven, and its texture more or less slaty. It is opake, of a greasy lustre, and may be scraped with a knife. It adheres firmly to the tongue, stains the fingers in some degree, and, though soft, is very tough, and pulverized with difficulty. The specific gravity 2.0. When exposed to the action of the blowpipe, it becomes at first of a dark grey colour; but afterwards recovers its whiteness with little or no alteration: with borax it forms a light brown glass. Its component parts are

Silex	63.00
Alumina	23.00
Oxide of iron	1.25
Water	12.00
	99.25

It abounds in the island of Cimola, and was in great request by the ancients for its detergent properties; at present its use is almost entirely confined to the inhabitants of the island. It produces the same effects as fuller's earth, but in a higher degree.

CINCHONA, in botany, so named in honour of the Countess del Cinchon, lady of a Spanish viceroy, whose cure is said first to have brought the Peruvian bark into reputation, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. There are nine species. See BARK.

CINCHONIN, in chemistry: it has been supposed that a principle, analogous to animal gelatin exists in some vegetables, particularly in the Peruvian bark; this has been denominated cinchonin. In this principle it has been supposed that the febri-

fuge power of the bark resided, and some have gone so far as to recommend animal glue as a substitute for bark.

CINERARIA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx simple, many leaved, equal; pappus simple; receptacle naked. There are forty-one species, most of them natives of the Cape of Good Hope.

CINNA, in botany, a genus of the Monandria Digynia class and order. Natural order of grasses. Essential character: calyx glume two-valved, one-flowered; corolla glume two-valved; seed one. There is but one species, *viz.* C. arundinacea, a native of Canada.

CINNABAR, in mineralogy, a species of the genus Mercury, of which there are two sub species, *viz.* the dark red, and the bright red. The former occurs massive, disseminated, in blunt cornered pieces, in membranes, amorphous, dendritic, and fruticose; it occurs also crystallized. The specific gravity is from 7 to 10, and the constituent parts are

Mercury	81
Sulphur	15
Iron	4
	100

Before the blow-pipe, it is completely volatilized, giving a blue flame, and a smoke which has the odour of sulphur. Both species are found in Bohemia, Hungary, Transylvania, and many other parts of the continent; but the most important mercury mines are those of Almadin in Spain, which have been worked upwards of two thousand years. It is from this ore that the greatest quantity of the mercury of commerce is obtained. It is used also as a pigment, but not by any means equal to the artificial cinnabar. See the next article.

CINNABAR, in chemistry, is a sulphuret of mercury, and is prepared by mixing one part of sulphur with seven or eight of mercury, and by applying such a heat as to make them combine. The black powder, which they form is then exposed to heat sufficient to produce inflammation; after which the remaining mass is sublimed in close vessels. The sublimate is mercury in combination with sulphur; it is of a very fine red colour, and when levigated, is in common use as a pigment, under the name of cinnabar or vermillion.

CINNAMON is the bark of the laurus cinnamomum, indigenous in some of the Eastern Islands, but an inferior kind, taken from the laurus cassia, is often sold for, or mixed with it. Cinnamon is most grateful, aromatic, highly pungent, and yields a very fine cordial. The bark is used in many culinary preparations, and is generally taken from the tree by making an incision on the under side for the whole length of the branch, which causes the bark to curl, and to separate itself, almost voluntarily, when acted upon by the sun's heat. That from the smaller twigs is accounted the best: it should be thin, very brittle, and very hot to the tongue. What we use is the inner bark; the exterior rind being of no value.

CINNAMON *stone*, in mineralogy, a species of the genus Zircon, found at Columbo, in the island of Ceylon. It is known in Holland under the name of kanelstein, which signifies cinnamon stone, probably from its resemblance in colour to that spice.

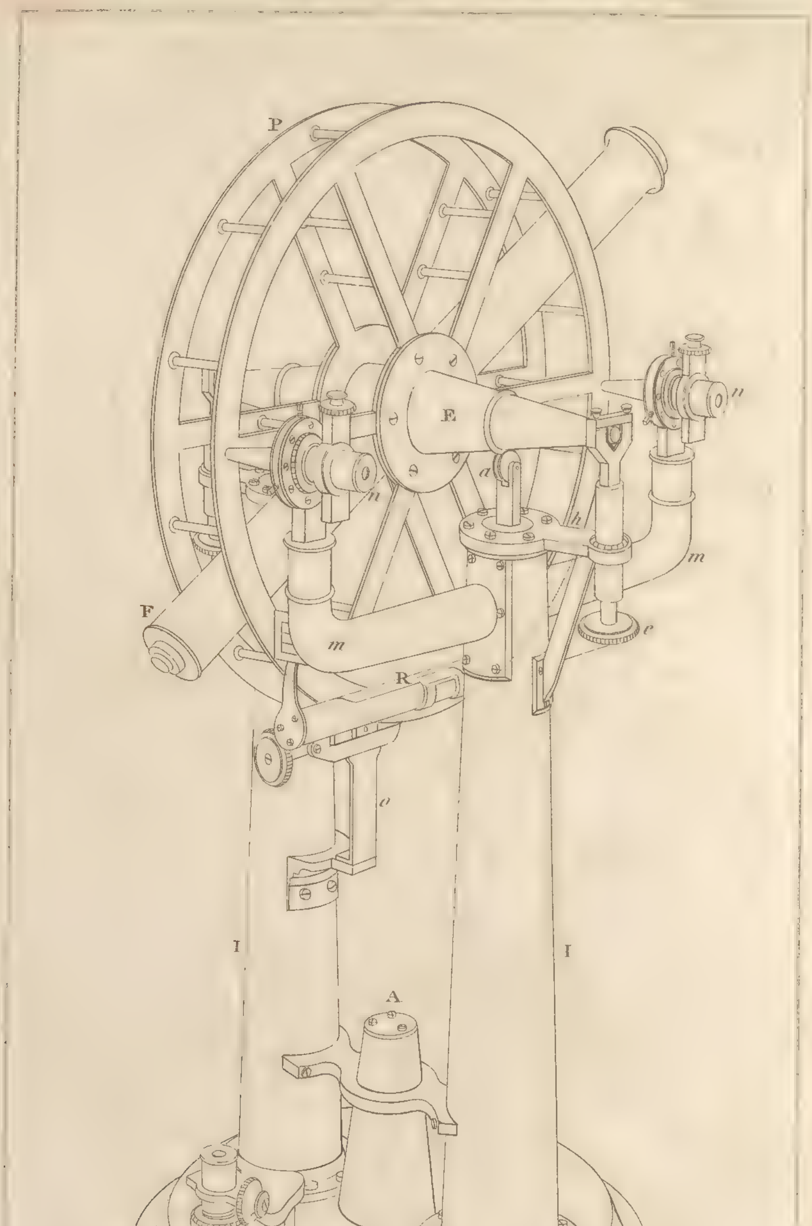
CINNAMON *tree*. See LAURUS CINNAMOMUM.

CINQUE PORTS, five havens that lie on the east part of England, towards France, thus called by way of eminence, on account of their superior importance, as having been thought by our kings to merit a particular regard, for their preservation against invasions. Hence they have a particular policy, and are governed by a keeper, with a title of the lord warden of the Cinque Ports, which office belongs to the constable of Dover; and their representatives are called Barons of the Cinque Ports.

They have various franchises, similar, in many respects, to those of the counties palatine, and particularly an exclusive jurisdiction before the mayor and jurats of the ports, their warden having the authority of an admiral among them, and sending out writs in his own name; and the king's writs do not run there. However, on a judgment in any of the king's courts, if the defendant hath no goods, &c. except in the ports, the plaintiff may get the records certified into chancery, and from thence sent by mittimus to the lord warden to make execution.

The Cinque Ports, it has been observed, are not "jura æqualia," like counties palatine, but are parcel of the county of Kent, so that if a writ be brought against one for land within the Cinque Ports, and he appears and pleads to it, and judgment is

TROUGHTON's *Portable Circular Instrument.*



J. Farey Jun.r delin

London. Published by Longman, Hurst, Rees & Orme, 1809.

Lowry sculp

given against him in the Common Pleas, this judgment shall bind him, for the land is not exempted out of the county, and the tenant may wave the benefit of his privilege. These five ports are Dover, Hastings, Romney, Hythe, and Sandwich; to which Winchelsea and Rye have been since added.

CIPHER. See CYPHER.

CIRCÆA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Aggregatæ. Onagræ, Jussieu. Essential character: corolla two-petalled; calyx two-leaved, superior; seed one, two-celled. There are two species; *viz.* C. lutetiana, common enchanter's nightshade, and C. alpina, mountain enchanter's nightshade.

CIRCLE, the name of various astronomical instruments for observing right ascensions, declinations, azimuths, altitudes, and likewise for the purposes of the most improved theodolite.

Plate "Circular Instrument" is a representation of an instrument made by Mr. Troughton, and of which he liberally permitted our draughtsman to take a drawing. It is an instrument which measures both horizontal and vertical angles with great accuracy, and is equally adapted for astronomical purposes and surveying.

The instrument is supported on three screws, two of which, *x*, *y*, are shewn in the figure; the three arms through which these pass meet in the centre, and hold a strong, vertical steel axis, truly turned, and very exactly fitted into two sockets, one at the top and the other at the bottom of a cone, A: upon this axis the upper part of the instrument turns. B is the azimuth circle laying upon the three arms of the tripod, and capable of turning round on the steel axis before mentioned: it is held by a screw, *g*, which moves the circle slowly round when turned: this motion is to adjust the circle, so that the plane of the verticle circle, P, shall be in the meridian when the index is set to zero. The circle is divided into degrees and every five minutes, and the microscope subdivides them into seconds. Another similar microscope is fixed diametrically opposite, upon the circular plate H, and turns round upon the vertical axis with the rest of the instrument. (For the constructions of these microscopes see that article.) I, I, are two hollow conical pillars, screwed on the index plate to support the axis of the vertical circle, P, by means of two bars (one only of which can be seen, *h*), screwed at the top of the pillars, and holding at their outer ends tubes, which contain angular bearings for the pivots of the axis; these bearings, or Y's, as they are called, from resembling that letter, can be elevated or depressed by screws, *e*, beneath them, to bring the axis parallel to the plane of the azimuth circle. *m*, *m*, are two crooked hollow tubes, screwed to the upright pillars, holding two microscopes, *n*, *n*; reading divisions diametrically opposite to each other on the vertical circle P. The vertical circle is composed of two circles, each cut from a solid plate, and attached to two flanches on a hollow conical axis E; they are firmly braced together by short pillars, as in the figure; between the circles the telescope F is fixed, it is 30 inches long and 2 in diameter. O is a thin plate of metal, screwed to the further main pillar, I, by its lower end, and its upper end supporting a clamp for fixing the circle when set at any elevation, and a screw for moving it slowly a small quantity after clamping. A similar screw, for occasionally attaching the index plate, H, to the azimuth circle, B, is seen at *p*. *a* is a small roller, pushed upwards by a spring, I; it acts against a ring upon the conical axis E, and its use is to support part of the weight of the circle and telescope, and take the bearing from the pivots at the end of the axis. R is a spirit level hung to the two horns *m*, *m*, and adjustable by a screw at its end. S is a telescope beneath the instrument, which is set to any distant object when the instrument is in use, and serves to shew that the instrument does not change its position. See OBSERVATORY and SURVEYING.

CIRCLE, in geometry, a plane figure comprehended by a single curve line, called its circumference, to which right lines, or radii, drawn from a point in the middle, called the centre, are equal to each other.

The area of a circle is found by multiplying the circumference by the fourth part of the diameter, or half the circumference by half the diameter: for every circle may be conceived to be a polygon of an infinite number of sides, and the semidiameter must be equal to the perpendicular of such a polygon, and the circumference of the circle equal to the periphery of the polygon: therefore half the circumference multiplied by half the diameter, gives the area of the circle.

Circles, and similar figures inscribed in them, are always as the squares of the diameters; so that they are in a duplicate

ratio of their diameters, and consequently of their radii.

A circle is equal to a triangle, the base of which is equal to the periphery, and its altitude to its radius: circles therefore are in a ratio compounded of the peripheries and the radii.

To find the proportion of the diameter of a circle to its circumference. Find, by continual bisection, the sides of the incribed polygon, till you arrive at a side subtending any arch, however small; this found, find likewise the side of a similar circumscribed polygon; multiply each by the number of the sides of the polygon, by which you will have the perimeter of each polygon. The ratio of the diameter to the periphery of the circle will be greater than that of the same diameter to the perimeter of the circumscribed polygon, but less than that of the inscribed polygon. The difference of the two being known, the ratio of the diameter to the periphery is easily had in numbers very nearly, though not justly true. Thus Archimedes fixed the proportion at 7 to 22.

Wolfius finds it as 10000000000000000 to 31415926535897932: and the learned Mr. Machin has carried it to one hundred places, as follows: if the diameter of a circle be 1, the circumference will be 3,14159, 26535, 89793, 23846, 26433, 83279, 50288, 41971, 69399, 37510, 58209, 74944, 59230, 78164, 05286, 20899, 86280, 34825. 34211, 70679 of the same parts. But the ratios generally used in practice are that of Archimedes, and the following; as 106 to 333, as 113 to 355, as 1702 to 5347, as 1815 to 5702, or as 1 to 3.14159.

Circle, *the quadrature of the*, or the manner of making a square, whose surface is perfectly and geometrically equal to that of a circle, is a problem that has employed the geometricians of all ages.

Many maintain it to be impossible; Des Cartes, in particular, insists on it, that a right line and a circle being of different natures, there can be no strict proportion between them: and in effect we are at a loss for the just proportion between the diameter and circumference of a circle.

Archimedes is the person who has come nearest the truth; all the rest have made paralogisms. Charles V. offered a reward of 100,000 crowns to the person who should solve this celebrated problem; and the States of Holland have proposed a reward for the same purpose.

Circle, *great*, *of the sphere*, that which having its centre in the centre of the sphere, divides it into two equal hemispheres; such are the equator, ecliptic, horizon, the colures, and the azimuths, &c. See Equator, Ecliptic, &c.

Circle, *lesser*, *of the sphere*, that which having its centre in the axis of the sphere, divides it into two unequal parts: these are usually denominated from the great circles to which they are parallel, as parallels of the equator.

Circle *of curvature*, a circle, the curvature of which is equal to that of a certain curve at a given point.

Circle, *horary*, on the globe, a brazen circle fixed on every globe with an index, to shew how many hours, and consequently how many degrees any place is east or west of another.

Circle *of perpetual apparition*, one of the lesser circles, parallel to the equator, described by any point touching the northern point of the horizon, and carried about with the diurnal motion: all the stars included within this circle are always visible above the horizon.

Circle *of perpetual occultation*, another circle at a like distance from the equator, on the south, containing all those stars which never appear in our hemisphere.

Circles, *diurnal*, are immoveable circles, supposed to be described by the several stars and other points of the heavens, in their diurnal rotation round the earth; or rather, in the rotation of the earth round its axis.

Circles *of latitude*, or *secondaries of the ecliptic*, are great circles perpendicular to the plane of the ecliptic, passing through the poles of it, and through every star and planet. They serve to measure the latitude of the stars, which is an arch of one of those circles intercepted between the star and the ecliptic.

Circles *of longitude* are several lesser circles parallel to the ecliptic, still diminishing in proportion as they recede from it; on these the longitude of the stars is reckoned.

Circles *of declination*, on the globe, are with some writers, the meridians on which the declination or distance of any star from the equinoctial is measured.

Circles, *horary*, in dialling, are the lines which shew the hours on dials, though these be not drawn circular, but nearly straight.

Circles, *polar*, are parallel to the equator, and at the same distance from the poles that the tropics are from the equator. See Arctic.

Circles *of position*, are circles passing through the common intersections of the horizon and meridian, and through any degree of the ecliptic, or the centre of any star, or other point in the heavens; and are used for finding out the situation or position of any star.

Circles, *Druidical*, a name given to certain ancient inclosures, formed by rude stones circularly arranged. These, it is supposed, were temples, or places for solemn assemblies for councils, or seats of judgment. These temples, though generally circular, occasionally differ in magnitude. The most simple were composed of one circle. Stonehenge consisted of two circles and two ovals, respectively concentric. One near St. Just, in Cornwall, is formed of four intersecting circles. In magnitude these differ very much: some are formed of only 12 stones, while others, as Stonhenge and Abury, contained, the first 140, and the second 652, and occupied many acres of ground. These different numbers, measures, and arrangements are supposed to have had reference, either to the astronomical divisions of the year, or some mysteries of the Druidical religion.

CIRCUIT, in electricity, denotes the course of the electrical fluid from the charged surface of an electric body to the opposite surface on which the discharge is made.

Circuit, in law, signifies a longer course of proceedings than is needful to recover the thing sued for; in case a person grants a rent-charge of 10*l.* a year out of his manor, and afterwards the grantee disseises the grantor, who thereupon brings an assise, and recovers the land, and 20*l.* damages; which being paid, the grantee brings his action for 10*l.* of the rent, due during the time of the disseism; this is termed circuity of action, because as the grantor was to receive 20*l.* damages, and pay 10*l.* rent, he might only have received the 10*l.* for the damages, and the grantee might have retained the other 10*l.* for his rent, and by that means saved his action.

Circuit also signifies the journey, or progress, which the judges take twice every year, through the several counties of England and Wales, to hold courts and administer justice, where recourse cannot be had to the King's courts at Westminster; hence England is divided into six circuits, *viz.* The home circuit, Norfolk circuit, Midland circuit, Oxford circuit, Western circuit, and Northern circuit. In Wales there are but two circuits, North and South Wales. Two judges are assigned by the King's commission to every circuit. In Scotland there are three circuits, *viz.* the Southern, Western, and Northern, which are likewise made twice every year, *viz.* in spring and autumn.

CIRCULAR *lines*, in mathematics, such straight lines as are divided from the divisions made in the arch of the limb, such as sines, tangents, secants, chords, &c.

Circular *numbers*, called also spherical ones, according to some are such whose powers terminate in the roots themselves. Thus, for instance, 5 and 6, all whose powers do end in 5 and 6, as the square of 5 is 25, the square of 6 is 36, &c.

CIRCULATION *of the blood*, the natural motion of the blood in a living animal, whereby that fluid is alternately carried from the heart to all parts of the body by the arteries, and returned from the same parts to the heart by the veins. See Physiology.

CIRCUMFERENCE, in a general sense, denotes the line or lines bounding a plane figure. However, it is generally used in a more limited sense, for the curve line which bounds a circle, and otherwise called a periphery; the boundary of a right-lined figure being expressed by the term perimeter.

The circumference of every circle is supposed to be divided into 360 degrees. The angle at the circumference of a circle is double that at the centre. For the ratio of the circumference of a circle to its radius, see Circle.

CIRCUMFERENTOR, a mathematical instrument used by land-surveyors for taking angles by the magnetic needle. It is an instrument (where great accuracy is not desired) much used in surveying, in and about woodlands, commons, harbours, sea-coasts, in the working of coal-mines, &c. &c. where a permanent direction of the needle is of the most material consequence in surveying. The instrument is made of brass, and, in its most simple state, consists of the following parts: a brass compass box, about five inches diameter, or more; on the plate of the box are engraved and lettered the principal points of the compass, divided into four quarters of 90 degrees each, two of the quarters being figured from the south point, and terminated by 90 degrees at the east and west; and the other two quarters from the north point, terminating also at the east and west: on the circumference of the plate is fixed a ring, divided into 360

degrees, numbered from 0 to 360; the observer may therefore take his angles as bearing from the north and south towards the east and west; or, by that which is the most usual method, the whole circumference of a circle of 360 degrees, commencing from the north point: a magnetic needle of the usual kind turns upon an iron point, fixed in the centre of the compass plate: a stop and trigger wire is applied to the compass box to throw the needle off its centre when not in use, in order to preserve the fineness of the centre point: a glass and brass spring ring covers the needle and closes the box: to the under side of the compass box, at the N. and S. points, is connected a bar about 15 inches long, from end to end, to each end of which is fixed a perpendicular brass sight about five inches long; each sight containing a long slit or perforation, and a sight line, so that the observer may take his line of sight, or observation of the line, upon the station mark, at which end of the bar he pleases.

CIRCUMSCRIBED, in geometry, is said of a figure which is drawn round another figure, so that all its sides or planes touch the inscribed figure.

Circumscribed *hyperbola*, one of Sir Isaac Newton's hyperbolas of the second order, that cuts its asymptotes, and contains the parts cut off within its own space.

CIRCUMSCRIBING, in geometry, denotes the describing a polygonous figure about a circle, in such a manner that all its sides shall be tangents to the circumference. Sometimes the term is used for the describing a circle about a polygon, so that each side is a chord; but in this case it is more usual to say the polygon is inscribed than the circle is circumscribed.

CIRCUMVALLATION, or *line of circumvallation*, in the art of war, is a trench bordered with a parapet, thrown up quite round the besieger's camp, by way of security against any army that may attempt to relieve the place, as well as to prevent desertion. See Fortification.

CIRRUS, in botany, a *clasper* or *tendril:* that fine spiral string or fibre, put out from the foot-stalks, by which some plants, as the ivy and vine, fasten themselves to walls, pales, or trees, for support. It is ranked by Linnæus among the fulcra, or parts of plants that serve for support, protection, and defence. Tendrils are sometimes placed opposite to the leaves, as in the vine; sometimes at the side of the foot-stalk of the leaf, as in the passion-flower; and sometimes, as in the winged-pea, they are emitted from the leaves themselves.

CIRSOCELE, or *hernia varicosa*, in surgery, a preternatural distension or divarication of the spermatic veins in the process of the peritonæum.

CISSAMPELOS, in botany, a genus of the Dioecia Monadelphia class and order. Natural order of Sarmentaceæ. Menisperma, Jussieu. Essential character: male, calyx four-leaved; corolla none; nectary wheel-shaped; stamina four, with cornate filaments. Female, calyx one-leafed, ligulate, roundish; corolla none; styles three; berry one-seeded. There are three species.

CISSOID, in geometry, a curve of the second order, first invented by Diocles, whence it is called the cissoid of Diocles.

Sir Isaac Newton, in his appendix "De Æquationum Constructione lineari," gives the following elegant description of this curve, and at the same time shews how, by means of it, to find two mean proportionals, and the roots of a cubic equation, without any previous reduction. Let A G (Plate III. Miscel. fig. 12) be the diameter, and F the centre of the circle belonging to the cissoid; and from F draw F D, F P, at right angles to each other, and let F P be $= AG$; then if the square P E D be so moved that one side E P always passes through the point P, and the end D of the other side E D slides along the right line F D, the middle point C of the side E D will describe one leg G C of the cissoid; and by continuing out F D on the other side F, and turning the square about by a like operation, the other leg may be described.

This curve may likewise be generated by points in the following manner:

Draw the indefinite right line B C (fig. 13) at right angles to A B the diameter of the semicircle A O B, and draw the right lines A H, A F, A C, &c. then if you take $AM = LH$, $AO = OF$, $ZC = AN$, &c. the points M, O, Z, &c. will form the curve A M O Z of the cissoid.

Cissoid, *properties of the:* it follows from genesis that drawing the right lines P M, K L, perpendicular to A B, the lines A K, P N, A P, P M, as also A P, P N, A K, K L, are continual proportionals, and therefore that $AK = PB$, and $PN = IK$. After the same manner it appears that the cissoid A M O, bisects the semicircle A O B. Sir Isaac Newton, in his last letter to Mr. Leibnitz, has shewn how to find a right line equal to one of the legs of this curve by

means of the hyperbola; but suppressed the investigation, which, however, may be seen in his fluxions. The cissoidal space contained under the diameter A B, the asymptote B C, and the curve A O Z of the cissoid, is triple that of the generating circle A O B.

CISSUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Hederaceæ. Vites, Jussieu. Essential character: berry one-seeded, surrounded by the calyx, and four-parted corolla. There are fifteen species; natives of both Indies.

CISTUS, in botany, *rock rose*, or *gum cistus*, a genus of the Polyandria Monogynia class and order. Natural order of Rotaceæ. Cisti, Jussieu. Essential character: corolla five-petalled; calyx five-leaved, with two of the leaflets smaller; capsule. There are sixty-six species, all of which are great ornaments to a garden; their flowers, though of short duration, are succeeded by fresh ones almost every day for about two months successively; the flowers are the size of a middling rose, but single and of various colours; the plants continue their leaves all the year; they are most of them hardy enough to live in the open air all the winter, except in very severe ones, which often destroy many of them; so that a plant or two of each sort should be kept in pots and sheltered to preserve the kinds. They are natives of warm climates.

CITADEL, a place fortified with four five, or six bastions, built on a convenient ground near a city, that it may command it in case of a rebellion. The city therefore is not fortified on the part opposite to the citadel, though the citadel is against the city. The best form for a citadel is a pentagon, a square being too weak, and a hexagon too big.

CITATION, in ecclesiastical courts, is the same with summons in civil courts. A person is not to be cited out of the diocese where he lives, unless it be by the archbishop in default of the ordinary, or where the ordinary is party to the suit, and in cases of appeal.

CITHAREXYLUM, in botany, *English fiddle-wood*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-toothed, bell-form; corolla funnel-wheel-form; segments above, equal; berry two-seeded; seeds two-celled. There are five species; all natives of the West Indies.

CITIES, *rise of*. After the fall of the Roman Empire the proprietors of land lived principally on their own estates; the towns were inhabited by mechanics and tradesmen, chiefly in the condition of slaves. The people, to whom it was granted as a privilege that they might give away their own daughters in marriage without the consent of their lord, and that upon their death their own children and not their lord should succeed to their goods, must have previously been in entirely or nearly the same state of villanage as the occupiers of land in the country. They seem to have been much on a level with the hawkers and pedlars of modern times.

They were generally obliged to pay some tax or toll for the privilege of selling their goods at particular places. As this source of revenue was thought of some importance by the feudal sovereigns and lords, in order to ensure its regular payment they were induced in many instances to farm it out for a certain sum to the inhabitants of different towns, who, in order to enforce its payment by the traders, were invested with the powers and privileges still possessed by the corporations of cities and boroughs. A town thus became a privileged place, of which traders were not only the inhabitants but the governors, at least in all that related to internal management.

The turbulent feudal lords were often incited by the riches of the burghs to attempt to plunder their houses and warehouses; hence the owners naturally feared and hated the lords; the sovereigns of the different states of Europe, for other reasons, likewise hated and feared the lords; this served as a bond of union between the sovereigns and the corporate towns, and enabled the towns to gain great privileges from those sovereigns who most needed their assistance, as King John in England; and in some instances to become independent, as was the case with the little republics of Italy, and the imperial cities in Germany.

CITRATES, in chemistry, salts formed by the combination of the citric acid, and alkalies and earths: thus we have the citrate of potash; the citrate of soda, &c. See CITRIC ACID.

CITRIC *acid*, in chemistry, is found in the juice of lemons and limes, and is that which gives it the sour taste. It is mixed, however, with mucilaginous and extractive matter. Scheele found that it could not

be obtained pure and crystallized by mere evaporation of the lemon juice, and that even the addition of alcohol did not separate completely the foreign matter. The process he followed is to saturate the expressed juice of the lemon, by the addition of chalk. The citric acid, combining with the lime, forms an insoluble compound, which of course precipitates. This is well washed with warm water, until the water pass off colourless; and in this way the mucilage and extractive matter are abstracted. The citrate of lime is then subjected to the action of as much sulphuric acid, previously diluted, as is sufficient to saturate the lime of the quantity of chalk that has been employed. The citric acid is disengaged and dissolved by the water: the mixture is boiled for a few minutes, to facilitate the precipitation of the sulphate of lime, and is then filtered. The filtered liquor is evaporated to the consistence of syrup, any sulphate of lime separated during the evaporation being withdrawn; and, on cooling and standing for some time, the citric acid is obtained in needle-like crystals.

Citric acid exists in a number of other fruits, from which it may be extracted, and much, it is said, of what is at present found in the shops, is prepared from the juice of the lime. From Vauquelin's analysis of the pulp of the tamarind, it appears to be the chief acid constituent of that fruit; one pound of the common prepared pulp of the shops containing an ounce and a half, with smaller quantities of malic and tartaric acids. This acid is very soluble in water. At a moderate temperature, 100 parts of water dissolve 75 parts, cold being produced during the solution; at 212° it dissolves twice its weight of it. Like the other vegetable acids, its solution undergoes spontaneous decomposition, though not very readily. The more powerful acids decompose it, though with some difficulty. Concentrated sulphuric acid converts it into acetic acid. Scheele remarked, that nitric acid did not convert it, as it did some of the other vegetable acids, into oxalic acid; but Fourcroy and Vauquelin have found, that when acted on by a large quantity of nitric acid for a long time, it affords a small portion of oxalic, with a larger portion of acetic acid.

Citric acid combines with the alkalies and earths, forming salts denominated citrates. The citrate of potass is very soluble, and does not crystallize but with difficulty, and is deliquescent: its taste is purely saline, and rather mild. It contains 55.55 of acid, and 44.45 of alkali. Citrate of soda is likewise very soluble, requiring little more than its weight of water for its solution: it crystallizes in six-sided prisms, and the crystals are slightly efflorescent. Their taste is faintly saline; the proportions of the solid salt are 60.7 of acid, and 39.3 of soda. Citrate of ammonia is equally or even more soluble than the others, and does not crystallize but when its solution is much concentrated: the form of its crystals is an elongated prism. It consists of 62 of acid, and 38 of ammonia. The earthy citrates are in general less soluble. When the solution of barytes is poured into the acid, a precipitate, soluble in the liquid by agitation, is formed; when the whole is saturated, the salt is deposited at first in the form of a powder, which is covered afterwards with a kind of crystalline efflorescence, and which a large quantity of water dissolves. It consists of 50 of acid, and 50 of base. When the citric acid is saturated by lime, small crystals are deposited, which are very sparingly soluble: 100 parts contain 62.66 of acid, and 37.34 of lime. When saturated by magnesia, the concentrated solution does not easily crystallize regularly, but rather assumes the state of a white, opaque, and somewhat spongy salt. The proportions of the salt, are 66.66 of acid, and 33.34 of base.

Vauquelin has likewise examined the action of citric acid on the metals. It does not dissolve silver; but it combines with its oxide, and forms a salt insoluble, of a harsh and strong metallic taste, and which, like the other salts of silver, is blackened by light: it is also decomposed by heat, sometimes leaving metallic silver intermixed with charcoal. It consists of 36 of acid, and 64 of oxide.

Citric acid, in its crystallized state, can be preserved for any length of time without decomposition; and a grateful lemonade may be prepared from it, by dissolving 30 or 40 grains in a pint of water, with the addition of a little sugar; and to communicate flavour, a little lemon peel, or powder, formed by rubbing sugar on the fresh lemon. The lemon juice may be regarded as a specific in scurvy, and there is every probability that the crystallized citric acid may be equally effectual.

CITRUS, in botany, a genus of the Polyadelphia Icosandria class and order. Natural order of Bicornes. Aurantia, Jussieu. Essential character: calyx five-cleft; petals five, oblong; anthers twenty; filaments

united into various bodies; berry nine-celled. There are five species; of which we shall notice the C. aurantium, orange-tree; of this there are sixty varieties. 1. Seville orange, which is a handsome tree, and the hardiest of any as it shoots freely in this country, and yields fruit of excellent quality for domestic uses. 2. The China orange, which does not come to perfection here, but in warm countries it grows in the open ground. 3. The forbidden-fruit tree, which resembles the common orange, but the fruit when ripe is larger and longer than the biggest orange: besides these there are the horned orange; the hermaphrodite orange, and the dwarf. C. medica, the citron tree; of this species the lemon tree is accounted a variety; of which there are many sorts. The flowers of all the species appear in May and June, and the fruit continues setting in June and July, and ripens the year following.

CIVET, a kind of perfume, bearing the name of the animal whence it is taken. The animal, commonly known by the name of the civet, or civet-cat, is the viverra civetta of Linnæus.

The civet is an animal of a wild disposition, and lives in the usual manner of others of this genus, preying on birds, the smaller quadrupeds, &c. It is a native of several parts of Africa and India; but not of America, as some have erroneously asserted; though it has been transported from the Phillippine Islands, and the coast of Guinea. This animal, as well as the zibet, though originally natives of the warm climates of Africa and Asia, are capable of subsisting in temperate and even in cold countries, provided they are defended from the injuries of the weather, and fed with succulent nourishment. Numbers of them are kept in Holland, for the sake of procuring and selling the perfume which they yield, called civet, and sometimes erroneously confounded with musk. There is a considerable traffic of civet from Bassora, Calicut, and other places, where the animal that produces it is bred; though great part of the civet among us is furnished by the Dutch, who rear a considerable number of the animals. That which is obtained from Amsterdam is preferred to that which comes from the Levant or India, because the latter is generally less pure. That brought from Guinea would be the best, if the negroes, as well as the Indians and Levanters, did not adulterate it with the juices of plants, or with labdanum, storax, and other balsamic and odoriferous drugs. The quantity supplied depends much on the quality of the nourishment, and the appetite of the animal, which always produces more in proportion to the goodness of its food. See VIVERRA.

CIVIL *death*, any thing that retrenches or cuts off a man from civil society, as a condemnation to the hulks, perpetual banishment, condemnation to death, outlawry, and excommunication.

CIVIL *law*, is that law which every particular nation, commonwealth, or city, has established peculiarly for itself. The civil law is either written or unwritten; and the written law is public or private; public, which immediately regards the state of the commonwealth, as the enacting and execution of laws, consultations about war and peace, establishment of things relating to religion, &c.; private, that more immediately has respect to the concerns of every particular person. The unwritten law, is custom introduced by the tacit consent of the people only, without any particular establishment. The authority of it is great, and it is equal with a written law, if it be wholly uninterrupted, and of a long continuance.

The civil law is allowed in this kingdom in the two universities, for the training up of students, &c. in matters of foreign treaties between princes; marine affairs, civil and criminal; in the ordering of martial causes; the judgment of ensigns and arms, rights of honour, &c.

CIVIL *list*, the money allotted for the support of the King's household, and for defraying certain charges of government.

CIVIL *year*, is the legal year, or annual account of time, which every government appoints to be used within its own dominions, and is so called in contradistinction to the natural year, which is measured exactly by the revolution of the heavenly bodies.

CIVILIAN, in general, denotes something belonging to the civil law; but more especially the doctors and professors thereof are called civilians: of these we have a college or society in London, known by the name of Doctors-commons.

CLAIM, a challenge of interest in any thing, that is in the possession of another, or at least out of a man's own; as claim by charter, by descent, &c.

CLAIRAULT (ALEXIS CLAUDE), a celebrated French mathematician and academician, was born at Paris the 13th of May, 1713. His father, a teacher of mathematics at Paris, was his sole instructor, teaching

him even the letters of the alphabet on the figures of Euclid's Elements, by which he was able to read and write at four years of age. By a similar stratagem it was that calculations were rendered familiar to him. At nine years of age he put into his hands Guisnée's Application of Algebra to Geometry; at ten he studied l'Hospital's Conic Sections; and between twelve and thirteen he read a memoir to the Academy of Sciences concerning four new geometrical curves of his own invention. About the same time he laid the first foundation of his work upon curves that have a double curvature, which he finished in 1729, at sixteen years of age. He was named Adjoint-Mechanician to the Academy in 1731, at the age of eighteen, Associate in 1733, and Pensioner in 1738. During his connection with the Academy he had a great multitude of learned and ingenious communications inserted in their memoirs, besides several other works which he published separately. In the year 1750, the Academy of Petersburgh proposed a prize on the subject of the lunar motions, which Clairault obtained: and in a few years he obtained another prize on the same subject. He was during life a most active and indefatigable man. He died in 1765, at the age of 52. His works are numerous, and his papers, inserted in the memoirs of the academy, may be found in the year 1727, and also for almost every year till 1762; being upon a variety of subjects, astronomical, mathematical, optical, &c.

CLAMP *in a ship*, denotes a piece of timber applied to a mast or yard, to prevent the wood from bursting; and also a thick plank lying fore and aft under the beams of the first orlop, or second deck, and is the same that the rising timbers are to the deck.

Clamp is likewise the term for a pile of unburnt bricks built up for burning. These clamps are built much after the same manner as arches are built in kilns, *viz.* with a vacuity betwixt each brick's breadth for the fire to ascend by; but with this difference, that instead of arching, they truss over, or over span; that is, the end of one brick is laid about half way over the end of another, and so till both sides meet within half a brick's length, and then a binding brick at the top finishes the arch.

Clamp *nails*, such nails as are used to fasten on clamps in the building or repairing of ships.

CLAN, a term used in Scotland to denote a number of families of the same name, under a feudal chief, who protected them, and, in return for that protection, commanded their services as his followers, and led them to war, and on military excursions.

CLAP *net*, a device for catching larks. You entice the birds with calls, and when they are within your distance, you pull a cord, and your net flies up and claps over them.

CLARIFICATION, is the separation, by chemical means, of any liquid from substances suspended in it, and rendering it turbid. If a difference can be made between clarification and filtration, it is, that the latter is effected by mere mechanical means, but the former either by heat or by certain additions, the action of which may be considered as chiefly chemical. The liquors subjected to clarification are almost without exception those animal or vegetable juices, in which the matter that renders them turbid is so nearly of the same specific gravity with the liquor itself, that mere rest will not effect a separation. In these too the liquid is generally rendered thicker than usual by holding in solution much mucilage, which further entangles the turbid matter, and prevents it from sinking. Hence it is that vinous fermentation has so powerful an effect as a clarifier, since this process always implies the destruction of a portion of saccharine mucilage, and the consequent production of a thin limpid spirit.

Coagulating substances are great clarifiers when mixed with any turbid liquor, the process of coagulation entangling with it all matters merely suspended and not dissolved, and carrying them either to the top in the form of a scum, or to the bottom in the form of a thick sediment, according to circumstances. Thus, to clarify muddy cider, the liquor is beaten up with a small quantity of fresh bullock's blood, and suffered to stand at rest for some hours, after which the liquor above is as clear as water, and almost as colourless, and at the bottom is a thick tough cake, consisting of the coagulated blood which has carried down with it all the opaque matter suspended in the liquor. Albuminous and gelatinous substances act in the same manner. The effect of white of egg in this way is known to every one. It should be first mixed with the turbid liquor, without heat and by agitation. Afterwards, on applying less than a boiling heat, the albumen of the egg coagulates, and carries up with it all the opaque particles, leaving the rest beautifully clear and limpid. Sometimes clarification takes place in a very unaccountable manner. Thus, it is well known, that a handful of marl or clay will clarify a large

cistern of muddy water, and marl is also used with advantage in clarifying vinous liquors.

CLARINET, in music, a wind instrument of the reed kind, the scale of which, though it includes every semitone within its extremes, is virtually defective. Its lowest note is E, below the F cliff, from which it is capable, in the hands of good solo performers, of ascending more than three octaves. Its powers through this compass are not every where equal; the player, therefore, has not a free choice in his keys, being generally confined to those of C and F, which are the only keys in which the clarinet is heard to advantage. The music for this instrument is accordingly usually written in those keys.

CLARION, a kind of trumpet, whose tube is narrower, and its tone acuter and shriller than that of the common trumpet.

CLARO *obscuro*, or CLAIR *obscure*, in painting, the art of distributing to advantage the lights and shadows of a piece, both with regard to the easing of the eye, and the effect of the whole piece. See PAINTING.

CLASS, an appellation given to the most general subdivisions of any thing. Thus, in the Linnæan system of natural history, the animal creation is divided into six classes, *viz.* MAMMALIA, AVES, AMPHIBIA, PISCES, INSECTA, VERMES.

CLASS, in botany, denotes the primary division of plants into large groups, each of which is to be subdivided, by a regular downward progression, in orders, or sections as they are called by Tournefort, genera, and species, with occasional intermediate subdivisions, all subordinate to the division which stands immediately above them. So that the classes have been compared to the first layer of a truncated pyramid, which increases gradually as it receives the orders, genera, and occasional intermediate subdivisions, till at length it terminates in an immense base, consisting entirely of species. According to the definition of Linnæus, a class is founded on the agreement of the several genera with each other, in the parts of fructification, according to the principles of nature and art. It is observed, that, in the formation of classes, they should not be very numerous, and that their boundaries should be strongly and distinctly marked.

CLATHRUS, in botany, a genus of Fungi. Essential character: roundish, consisting of a reticular, windowed, hollow body; the ramifications connected on every side. Linnæus reckons only four species, other botanists seven and eight.

CLAVA, in natural history, a genus of Vermes Mollusca. Body fleshy, gregarious, clavate, and fixed by a round peduncle; aperture single and vertical. There is but one species, *viz.* C. parasitica, covered with pellucid conic erect spines. It inhabits the Baltic, on sea weeds, shell fish, and floating timber. Like the hydra, it possesses the power of dilating and contracting the mouth. See HYDRA.

CLAVARIA, in botany, a genus of Fungi; one of the lowest order in the scale of vegetation, differing sometimes very little in substance from the rotten wood whence it issues. It is a smooth oblong body, of one uniform substance.

CLAVICLES, in anatomy, are two bones situated transversely and a little obliquely opposite to each other, at the superior and anterior part of the thorax, between the scapula and sternum.

CLAUSE signifies an article, or particular stipulation, in a contract, a charge or condition in a testament, &c.

Thus we say, a derogatory clause, a penal clause, saving clause, codicillary clause, &c.

CLAY. Any natural earthy mixture, which possesses plasticity and ductility when kneaded up with water, is in common language called a clay. All mineralogists, however, have comprehended within the appellation, not only clays, properly so called, but a few other mineral substances nearly allied to some of the clays, and which become plastic by decomposition. Clay, however, is by no means strictly a mineral species, being in most cases the result of the decomposition of other minerals. It seems advisable therefore to consider the property of plasticity as an essential character, and to exclude from the class of clays all earthy bodies that are destitute of it.

Mineralogists have generally arranged all the plastic clays under two species, rather from the economical uses to which they are applied than according to their external characters, composition, or geological situation. The first species is the white infusible porcelain clay, and the second contains all the rest compounded together, under the general appellation potter's clay. We have, however, a different arrangement in Aikin's dictionary, which we shall lay before the reader.

Essential character: plastic by intimate mixture with water.

1. Porcelain clay. Its colour is generally reddish white, also greyish and yellowish

white: it has no lustre, no transparency. It occurs either friable or compact; stains the fingers; adheres to the tongue; is soft, but meagre to the feel; is easily broken. Specific gravity about 2.3. It falls to pieces in water, and by kneading becomes ductile, though not in a very great degree. The Cornish porcelain clay certainly originates from the decomposition of felspar, and contains particles of quartz, mica, and talc, from which it is separated by eleutriation. The Chinese kaolin also contains mica, and is probably of the same origin as the Cornish. The same remark may be applied to the French, &c. It is, however, by no means certain, that all porcelain clay is derived from felspar, as it varies considerably in its composition and fusibility; all the kinds indeed are infusible at any temperature less than a white heat; but some, especially the Japanese, are refractory in the most powerful furnaces. The Cornish clay, according to Wedgewood, consists of 60 per cent. alumina, and 40 silex.

2. Steatitic clay. Its colour is a light flesh red, passing into cream colour; its texture is minutely foliated; it has a slight somewhat greasy lustre, and takes a polish from the nail. It stains the fingers, is very friable, and has a smooth unctuous feel. When laid on the tongue it dissolves into a smooth pulp, without any gritty particles. It is very plastic, and has a strong argillaceous odour. It occurs in nodules, in a hard cellular horn-stone, that forms large mountainous masses near Conway, in North Wales, and originates from the decomposition of indurated steatite.

3. Clay from slate. Its colour is ash-grey, passing into ochre-yellow: its texture is foliated: it has a smooth unctuous feel, and its siliceous particles are so small, as to occasion scarcely any grittiness between the teeth. It occurs in thin beds on the tops of the softer kinds of slate-rock, and from its imperviousness to water is always found lining the bottoms of the peat-mosses with which this kind of mountains is generally covered, and in these situations it is of a white ash colour, being deprived of its iron and carbon by the acid of the peat. It also occurs in thicker beds at the foot of the mountains, but is of a darker colour, and less plastic.

4. Clay from shale. Its colour varies from greyish blue to bluish black: its texture is foliated: it has a smooth unctuous feel, takes a polish from the nail, is excessively tenacious and ductile, and has but a slight degree of grittiness. It occurs abundantly in all collieries, and is produced by the spontaneous decomposition of the shale with which the beds of coal are covered. A sandy clay, of a greyer colour, and more refractory nature, is procured from the decomposition of the indurated clay that forms the floor of the coal, and is provincially called clunch. The Stourbridge clay, from which crucibles, glass-house pots, &c. are made, is of this kind.

5. Clay from trap. At the foot of the softer rocks of trap-formation, such as wakke, clay-porphyry, and some varieties of grunstein and hornblende rock, are found in beds of clay, evidently originating from the gradual disintegration of these by the weather.

6. Marly clay. The colour of this is bluish, or brownish red: it occurs either compact or foliated: it has a soft unctuous feel, takes a polish by friction with the nail, is very plastic, more or less gritty, though not so much so as the common alluvial clay. It burns to a brick of a buff or deep cream colour, and at a high heat readily enters into fusion. It effervesces strongly with acids, and contains from $\frac{1}{4}$ to $\frac{1}{10}$ of carbonated lime. It originates sometimes from the decomposition of compact argillaceous limestone; but more frequently from the softer slaty varieties usually called stone marl. It is largely employed as a manure, and where the calcareous part does not exceed 10 or 12 per cent. it is esteemed as a material for bricks.

7. Clay from metallic veins. Its colour is grey, verging into bluish, greenish, and yellowish, or red. It has a smooth unctuous feel; is very tenacious; often contains sulphuric acid, and certain metallic oxides, which are never observed in other clays, such as lead, silver, antimony, copper, and bismuth. Is found in metallic veins.

8. Alluvial clay. The circumstances which characterize alluvial clay are the following. It contains a larger proportion of quartz sand than the preceding; rounded pebbles of various kinds are also imbedded in it; thus showing it to have been carried from its native situation, and mingled in its progress with a variety of extraneous bodies. At least three kinds of it may be distinguished; *viz.* pipe clay, potter's clay, and chalky clay. Pipe clay is of a greyish or yellowish white colour, an earthy fracture, and a smooth greasy feel: it adheres pretty strongly to the tongue; is very plastic and tenacious; when burnt is of a milk-white

colour; is difficultly fusible, though much more so than porcelain clay, from which it is further distinguished by its superior plasticity, and the sand which it contains. It is manufactured into tobacco-pipes, and is the basis of the white or queen's-ware pottery. Potter's clay is of a reddish, bluish, or greenish colour; has a somewhat fine earthy fracture, and a soft, often greasy, feel: it adheres to the tongue, and is very plastic. It burns to a hard, porous, red brick; and in a higher heat runs into a dark-coloured flag. When tempered with water, and mixed with sand, it is manufactured into bricks: those varieties that are the most free from pebbles are made into tiles and coarse red pottery. See ALUMINA.

CLAY *stone*, in mineralogy, is of a greenish, bluish, or grey colour, sometimes marked by brownish yellow spots and stripes. It occurs in mass, is opaque, dull, frangible, and soft. It forms large mountainous masses, occurring in beds and veins.

CLAYTONIA, in botany, so named in honour of Mr. John Clayton, a genus of the Pentandria Monogynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx two-valved; corolla five-petalled; stigma trifid; capsule three-valved, one-celled, three-seeded. There are two species, *viz.* C. Virginica and C. Sibirica.

CLEF, or CLIFF, in music, a mark set at the beginning of the lines of a song, which shows the tone or key in which the piece is to begin; or it is a letter marked on any line, which explains the rest. It is called clef, or key, because hereby we know the names of all the other lines, and consequently the quantity of every degree or interval: but because every note in the octave is also called a key, this letter marked is, for distinction-sake, denominated the signed clef; and by this key is meant the principal note of a song, in which the melody closes. See MUSIC.

CLEMATIS, in botany, *virgin's bower*, a genus of the Polyandria Polygamia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals four, sometimes five, or even six; seeds having a tail. There are twenty-one species.

CLEOME, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Putamineæ. Capparides, Jussieu. Essential character: nectareous glands three, at each sinus of the calyx, except the lowest; petals all ascending; silique one-celled, two-valved. There are twenty-three species, all of them natives of very warm countries.

CLEONIA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: filaments forked, with an anther at one of the tips; stigma four-cleft. There is but one species, *viz.* C. lusitanica, sweet-scented cleonia, is an annual plant, native of Spain and Portugal.

CLEPSYDRA, a water-clock, or instrument to measure time by the fall of a certain quantity of water.

The construction of a clepsydra. To divide any cylindrical vessel into parts, to be emptied in each division of time, the time wherein the whole, and that wherein any part is to be evacuated, being given. Suppose a cylindrical vessel, whose charge of water flows out in twelve hours, were required to be divided into parts, to be evacuated each hour. 1. As the part of time 1 is to the whole time 12, so is the same time 12 to a fourth proportional 144. 2. Divide the altitude of the vessel into 144 equal parts: here the last will fall to the last hour; the three next above to the last part but one; the five next to the tenth hour; lastly, the twenty-three last to the first hour. For since the times increase in the series of the natural numbers 1, 2, 3, 4, 5, &c. and the altitudes, if the numeration be in a retrograde order from the twelfth hour, increase in the series of the unequal numbers 1, 3, 5, 7, 9, &c. the altitudes computed from the twelfth hour will be as the squares of the times 1, 4, 9, 16, 25, &c. Therefore the squares of the whole time, 144, comprehend all the parts of the altitude of the vessel to be evacuated. But a third proportional to 1 and 12 is the square of 12, and consequently it is the number of equal parts in which the altitude is to be divided, to be distributed according to the series of the unequal numbers, through the equal interval of hours. There were many kinds of clepsydræ among the ancients; but they all had this in common, that the water ran generally through a narrow passage, from one vessel to another, and in the lower was a piece of cork or light wood, which, as the vessel filled, rose up by degrees, and showed the hour.

CLERGY, a general name given to the body of ecclesiastics of the Christian church, in contradistinction to the laity. The privileges and immunities which the clergy of the primitive Christian church enjoyed, deserve our notice. In the first place, when they travelled upon necessary

occasions, they were to be entertained by their brethren of the clergy, in all places, out of the public revenues of the church. When any bishop, or presbyter, came to a foreign church, they were to be complimented with the honorary privilege of performing divine offices, and consecrating the eucharist in the church. The great care the clergy had of the characters and reputations of those of their order, appears from hence, that in all accusations, especially against bishops, they required the testimony of two or three witnesses of good character: nor was any heretic admitted as an evidence against a clergyman. With regard to the respect paid to the clergy by the civil government, it consisted chiefly in exempting them from some kind of obligations to which others were liable, and granting them certain privileges and immunities which others did not enjoy.

By the ecclesiastical laws, no clergyman was allowed to relinquish his station without just grounds and leave; but in some cases resignation was allowed of, as in old age, sickness, or other infirmities.

The privileges of the English clergy, by the ancient statutes, are very considerable: their goods are to pay no toll in fairs or markets; they are exempt from all offices but their own; from the king's carriages, posts, &c. from appearing at sheriff's tourns, or frank-pledges; and are not to be fined or amerced according to their spiritual, but their temporal means. A clergyman acknowledging a statute, his body is not to be imprisoned. If he be convicted of a crime, for which the benefit of clergy is allowed, he shall not be burnt in the hand; and he shall have the benefit of the clergy *in infinitum*, which no layman can have more than once.

The clergy, by common law, are not to be burdened in the general charges of the laity; nor to be troubled nor incumbered, unless expressly named and charged by the statute; for general words do not affect them: thus, if a hundred be sued for a robbery, the minister shall not contribute; neither shall they be assessed to the highway, to the watch, &c.

The revenues of the clergy were anciently more considerable than at present. Ethelwolph, in 855, gave them a tythe of all goods, and a tenth of all the lands in England, free from all secular services, taxes, &c. The charter whereby this was granted them, was confirmed by several of his successors; and William the Conqueror, finding the bishoprics so rich, created them into baronies, each barony containing thirteen knight's fees at least; but since the reformation the bishoprics are much impoverished. The revenues of the inferior clergy, in the general, are small, a third part of the best benefices being anciently, by the Pope's grant, appropriated to monasteries, upon the dissolution whereof they became lay-fees. Indeed an addition was made, 2 Annæ, the whole revenues of first-fruits and tenths being then granted to raise a fund for the augmentation of the maintenance of the poor clergy; pursuant to which, a corporation was formed, to whom the said revenues were conveyed in trust, &c.

Clergy, *benefit of.* See Benefit.

CLERK, a word originally used to denote a learned man, or man of letters: whence the term became appropriated to churchmen, who were from thence called clerks or clergymen; the nobility and gentry being usually bred up to the exercise of arms, and none left but the ecclesiastics to cultivate the sciences.

Clerk *of the affidavits*, the officer, in the court of Chancery, who files all affidavits made use of in court.

Clerk *of the assise*, the person who writes all things judicially done by the justices of assise, in their circuits.

Clerk *of the bails*, an officer in the court of King's Bench, whose business it is to file all bail-pieces taken in that court, where he always attends.

Clerk *of the check*, an officer belonging to the King's court, so called because he has the check and controlment of the yeomen of the guard, and all other ordinary yeomen that belong to the King, Queen, or Prince. He likewise, by himself or deputy, sets the watch in the court. There is also an officer in the navy of the same name, belonging to the King's yards.

Clerk *of the crown*, an officer in the King's Bench, who frames, reads, and records all indictments against offenders, there arraigned or indicted of any public crime. He is likewise termed clerk of the crown-office, in which capacity he exhibits informations by order of the court for divers offences.

Clerk *of the crown*, in chancery, an officer whose business it is constantly to attend the Lord Chancellor, in person or by deputy, to write and prepare for the great seal special matters of state by commission, both ordinary and extraordinary; *viz.* commissions of lieutenancy, of justices of assise, oyer and terminer, gaol-delivery, and of the

peace; all general pardons, granted either at the King's coronation, or in parliament: the writs of parliament, with the names of the knights, citizens, and burgesses, are also returned into his office. He also makes out special pardons, and writs of execution on bonds of statute-staple forfeited.

CLERK *of the declarations*, he that files all declarations after they are engrossed, in causes depending in the court of King's Bench.

CLERK *of the deliveries*, an officer of the Tower, whose function is to take indentures for all stores and ammunition issued from thence.

CLERK *of the errors*, in the court of Common Pleas, an officer who transcribes and certifies into the King's Bench, the tenor of the record of the action on which the writ of error, made out by the cursitor, is brought there to be determined. In the King's Bench the clerk of the errors transcribes and certifies the records of causes, by bill, in that court, into the Exchequer: and the business of the clerk of the errors in the Exchequer is to transcribe the records certified thither out of the King's Bench, and to prepare them for judgment in the Exchequer-chamber.

CLERK *of the essoins*, in the court of Common Pleas, keeps the essoin roll, or enters essoins: he also provides parchment, cuts it into rolls, marks the number on them, delivers out all the rolls to every officer, and receives them again when written. See ESSOIN.

CLERK *of the estreats*, an officer in the Exchequer, who every term receives the estreats out of the Lord Treasurer's remembrancer's office, and writes them out to be levied for the crown.

CLERK *of the hamper*, or *hanaper*, an officer in Chancery, whose business is to receive all money due to the King for the seals of charters, letters patent, commissions, and writs; also the fees due to the officers for enrolling and examining them.

CLERK *of the enrolments*, an officer of the court of Common Pleas, that inrols and exemplifies all fines and recoveries, and returns writs of entry.

CLERK *of the juries*, an officer of the Common Pleas, who makes out the writs called habeas corpus and distringas, for juries to appear either in that court, or at the assises, after the pannels are returned upon the *venire facias*. He likewise enters into the rolls the awarding these writs, and makes all the continuances till verdict is given.

CLERK *comptroller of the King's household*, an officer of the King's court, authorised to allow or disallow the charges of pursuivants, messengers of the green-cloth, &c. to inspect and control all defects of any of the inferior officers, and to sit in the counting-house with the Lord Steward and other officers of the household, for regulating such matters.

CLERK *of the King's silver*, an officer of the Common Pleas, to whom every fine is brought, after it has passed the office of the custos brevium; and who enters the effect of writs of covenant into a book kept for that purpose, according to which all the fines of that term are recorded in the rolls of the court.

CLERK *of the King's great wardrobe*, an officer who keeps an account of all things belonging to the wardrobe.

CLERK *of the market*, an officer of the King's house, to whom is given the charge of the King's measures and weights, the standards of those that ought to be used all over England.

CLERK *of the ordnance*, an officer that registers all orders concerning the King's ordnance in the Tower.

CLERK *of the outlawries*, an officer of the Common Pleas, and deputy to the Attorney General, for making out all writs of *capias utlagatum*, after outlawry, to which there must be the King's attorney's name.

CLERK *of the paper-office*, an officer belonging to the King's Bench, whose business is to make up the paper-books of special pleadings in that court.

CLERK *of the Parliament-rolls*, an officer in the House of Lords, and likewise in the House of Commons, who records all transactions in Parliament, and engrosses them fairly in parchment rolls.

CLERK *of the peace*, an officer belonging to the sessions of the peace, whose business is to read indictments, inrol the proceedings, and draw the process; he likewise certifies into the King's Bench transcripts of indictments, outlawries, attainders, and convictions had before the justices of the peace, within the time limited by statute, under a certain penalty. This office is in the gift of the *Custos Rotulorum*, and may be executed by deputy.

CLERK *of the pells*, an officer that belongs to the Exchequer, whose business is to enter every teller's bill into a parchment roll, called *pellis receptorum*, and to make another roll of payments, called *pellis exituum*.

CLERK *of the petty bag*, an officer o the

court of Chancery, whereof there are three, the Master of the Rolls being the chief: their business is to record the return of all inquisitions out of every shire, to make out patents of customers, gaugers, comptrollers, &c. liberates upon extents of statutes staple, *conge d'elires* for bishops, summons of the nobility, clergy, and burgesses to parliament, and commissions directed to knights, and others, of every shire, for assessing subsidies and taxes.

Clerk *of the pipe*, an officer of the Exchequer, who, having the accounts of all debts due to the King delivered out of the remembrancer's office, charges them in a great roll, folded up like a pipe. He writes out warrants to sheriffs, to levy the said debts on the goods and chattels of the debtors; and if they have no goods, then he draws them down to the treasurer's remembrancer, to write estreats against their lands.

Clerk *of the pleas*, an officer of the Exchequer, in whose office all the officers of the court, having special privilege, ought to sue, or be sued, in any action. In this office also actions at law may be prosecuted by other persons, but the plaintiff ought to be tenant or debtor to the King, or some way accountable to him. The under-clerks are attorneys in all suits.

Clerks *of the privy-seal*, four officers that attend the Lord-privy-seal, for writing and making out all things that are sent by warrant from the signet to the privy-seal, and to be passed the great-seal; and likewise to make out privy-seals, upon special occasions of his Majesty's affairs, as for loan of money, or the like.

Clerk *of the rolls*, an officer of the chancery, whose business is to make searches after, and copies of deeds, offices, &c.

Clerk *of the rules*, an officer of the court of King's Bench, who draws up and enters all the rules and orders made in court, and gives rules of course in divers writs.

Clerk *of the signet*, an officer continually attendant upon his Majesty's principal secretary, who has the custody of the privy signet, as well for sealing the king's private letters, as those grants which pass the king's hand by bill signed. There are four of these officers, who have their diet at the secretary's table.

Clerks, *six*, officers in chancery, next in degree below the twelve masters, whose business is to inrol commissions, pardons, patents, warrants, &c. which pass the great seal: they were anciently clerici, and forfeited their places if they married. They are also attorneys for parties in suits depending in the court of chancery.

Clerk *of the supersedeas*, an officer of the Common Pleas, who makes out writs of supersedeas, forbidding the sheriff to return the exigent upon a defendant's appearing thereto on an outlawry.

Clerk *of the treasury*, an officer belonging to the court of Common Pleas, who has the charge of keeping the records of the court, makes out all records of nisi prius, and likewise all exemplifications of records being in the treasury. He has the fees due for all searches; and has under him an under-keeper, who always keeps one key of the treasury door.

Clerk *of the warrants*, an officer of the Common Pleas, whose business is to enter all warrants of attorney for plaintiffs and defendants in suit; and to inrol deeds of bargain and sale, that are acknowledged in court, or before a judge. His office is likewise to estreat into the Exchequer all issues, fines, estreats, and amercements, which grow due to the crown in that court.

CLERODENDRUM, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-cleft, bell shaped; corolla with a filiform tube and a funnel shaped, five parted, equal border; stamina very long, gaping very much between the segments. Berry one-seeded. There are eight species, natives of the East Indies, China, and Japan.

CLETHRA, in botany, a genus of the Decandria Monogynia class and order. Nat. order of Bicornes. Ericæ, Jussieu. Essential character: calyx five parted; petals five; stigma trifid; capsule three-celled, three-valved. There are four species, natives of North America.

CLIBADIUM, in botany, a genus of the Monoecia Pentandria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: male common calyx imbricate; corolla of the disk five-cleft; female common calyx the same; corolla of the ray female, three or four; seed an umbilicate drupe. There is but one species, *viz.* C. surinamense, native of Surinam.

CLIFFORTIA, in botany, so named in honour of George Clifford, a merchant at Amsterdam, and a considerable botanist, a genus of the Dioecia Polyandria class and order. Natural order of Tricoccæ. Rosaceæ, Jussieu. Essential character: male

calyx three-leaved, superior; stamens about thirty. Female, calyx three-leaved, superior; corolla none; styles two; capsule two-celled; seed one. There are nineteen species, all shrubs from the Cape of Good Hope.

CLIMACTERIC, among physicians and natural historians, a critical year in a person's life, in which he is supposed to stand in great danger of death.

According to some, every seventh year is a climacteric; but others allow only those years produced by multiplying 7, by the odd numbers 3, 5, 7, and 9, to be climacterical. These years, they say, bring with them some remarkable change with respect to health, life, or fortune; the grand climacteric is the sixty-third year; but some, making two, add to this the eighty-first: the other remarkable climacterics are the seventh, twenty-first, thirty-fifth, forty-ninth, and fifty-sixth. The credit of climacteric years can only be supported by the doctrine of numbers introduced by Pythagoras; though many eminent men, both among the ancients and moderns, appear to have had great faith in it.

CLIMATE, in geography, a space upon the surface of the terrestial globe, contained between two parallels, and so far distant from each other, that the longest day in one differs half an hour from the longest day in the other parallel. The difference of climates arises from the different inclination or obliquity of the sphere: the ancients took the parallel wherein the length of the longest day is twelve hours and three quarters for the beginning of the first climate: as to those parts that are nearer to the equator than that parallel, they were not accounted to be in any climate, either because they may, in a loose and general sense, be considered as being in a right sphere, though, strictly speaking, only the parts under the equator are so; or because they were thought to be uninhabited by reason of the heat, and were besides unknown. The ancients, considering the diversity there is in the rising and setting of the heavenly bodies, especially the sun, and, in consequence thereof, the difference in the length of the days and nights in different places, divided as much of the earth as was known to them, into climates; and instead of the method now in use, of setting down the latitute of places in degrees, they contented themselves with saying in what climate the place under consideration was situated. According to them, therefore, what they judged the habitable part of the northern hemisphere was divided into seven climates, to which the like number of southern ones corresponded. A parallel is said to pass through the middle of a climate, when the longest day in that parallel differs a quarter of an hour from the longest day in either of the extreme parallels that bound the climate: this parallel does not divide the climate into two equal parts, but the part nearest to the equator is larger than the other, because the farther we go from the equator, the less increase of latitude will be sufficient to increase the length of the longest day a quarter of an hour.

Some of the moderns reckon the different climates by the increase of half an hour in the length of the longest day, beginning at the equator, and going on till they come to the polar circle towards the pole; they then count the climates by the increase of a whole natural day, in the length of the longest day till they come to a parallel, under which the day is of the length of fifteen natural days, or half a month; from this parallel they proceed to reckon the climates by the increase of half or whole months, in the artificial day, till they come to the pole itself, under which the length of the day is six months. Those between the equator and the polar circles, are called hour climates; and those between the polar circles and the poles, monthly climates. Vulgarly the term climate is bestowed on any country or region differing from one another, either in respect of the seasons, the quality of the soil, or even the manners of the inhabitants, without any regard to the length of the longest day.

CLIMAX, in rhetoric, a figure wherein the word or expression which ends the first member of a period begins the second, and so on; so that every member will make a distinct sentence, taking its rise from the next foregoing, till the argument and period be beautifully finished.

CLIMBING *plants*, in gardening, are such plants as ascend either spirally round supports, or by means of claspers and tendrils. They are either herbaceous or woody, and which, according to their mode of climbing, may be denominated twining climbers, cirrhous climbers, and parasitic climbers. The first sort includes all such as have winding stalks, and twist about any neighbouring support, such as scarlet kidney beans, hops, and some sort of honeysuckle. The second kind comprehends all

such as ascend by means of spiral strings, issuing from the sides of the stalks and branches, or from the foot-stalks of the leaves, and even from the leaves themselves, twisting about any thing they meet with, by which their stalks are supported and arrive at their proper height, such as most of the pea tribe, cucumber, vine, passion-flower, and various others. And the last plants are also of the same kind, but their claspers plant themselves as roots in the bark of the plants on which they ascend, or in the crevices of walls or pales, thereby supporting themselves, and mounting to their tops, as the ivy, virginia creeper, radicant bignonia, and several others.

CLINCHING, in the sea-language, a kind of slight caulking used at sea, in a prospect of foul weather, about the ports: it consists in driving a little oakum into their seams, to prevent the water's coming in at them.

CLINK *stone*, in mineralogy, nearly allied to BASALT, which see. It has received its name from the sound which it gives when struck. It occurs massive, and forms beds, and sometimes assumes the columnar form: its colour is grey, with shades of green and yellow. Its specific gravity is 2.5, and it is composed of

Silex	57.25
Alumina	23.5
Oxide of iron	2.25
Manganese	25
Soda	8.10
Water	3.
	94.35
Loss	5.65
	100

CLINOPODIUM, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: involucre many bristled, under the whorl. There are five species.

CLIO, in natural history, a genus of Vermes Mollusca; body oblong, noyant, generally sheathed, and furnished with two dilated membranaceous arms or wing-like processes; tentacula three, besides two in the mouth. There are six species. The C. retuso uses its arms or wings, which are submembranaceous, like a pair of oars.

CLITORIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: corolla inverted; standard very large, spreading, overshadowing the wings. There are five species.

CLITORIS. See ANATOMY.

CLOCK, in horology, is a machine which measures time with a degree of accuracy, that gives it a just preference over the clepsydræ, and other methods anciently used for the same purpose. See CLEPSYDRÆ.

The sphere of Archimedes, made two hundred years before the birth of Christ, is usually considered as the first attempt at the formation of a clock; it had, indeed, a maintaining power, but being without any kind of regulator, could only measure time, as a planetarium exhibits the motion of the stars, with relative, but not with positive precision.

In 1232, a machine for measuring time was sent by the Sultan of Egypt to the Emperor Frederic II. but this, if it had any regulating part, most probable had none superior to the flyer of a common roasting jack. Wallingford, at the begining of the fourteenth century, and Dondi at the end of the same, have each had the honour of being supposed the first inventors of clocks; the account given of Dondi's clock by Petrus Paulus Vergerius (in Vit. Princip. Carrar. tom. 16) makes it nearly similar to our church clocks; as, like them, it was placed on the upper part of a turret, or steeple, and spontaneously pointed out each of the twenty-four hours in succession. There is still, however, some doubt whether Dondi was the original inventor.

Boethius, at the end of the fifth century, Pacificus about the middle of the ninth, and Gerbert at the end of the tenth, are also regarded as the inventors of clocks, but on rather doubtful authority.

There are many documents to prove the existence of clocks, with wheels and weights, in the middle of the fourteenth century, and therefore there is more reason for assigning this period to the invention than any other.

On comparing the various testimonies relative to the origin of the clock, the fairest conclusion seems to be, that it is neither of so ancient a date as some writers suppose, nor yet among those more recent inventions, which are placed in the last two centuries, and that the first inventor is not certainly known.

The opinion of Fer. Berthoud, who has written more on the subject of clock-work

CLOCK WORK.

Fig. 1.

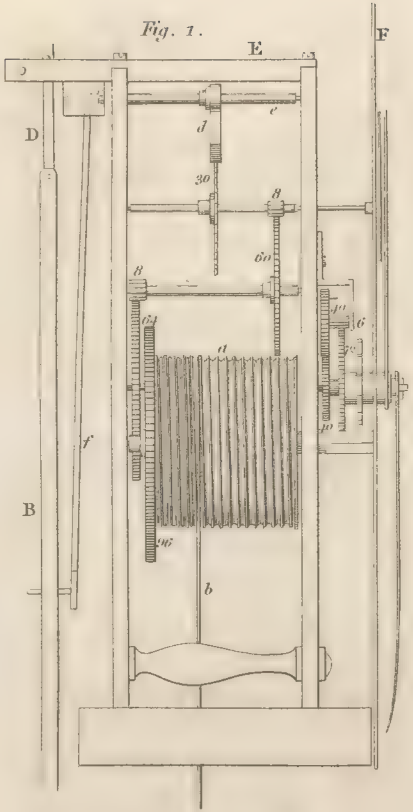


Fig. 2.

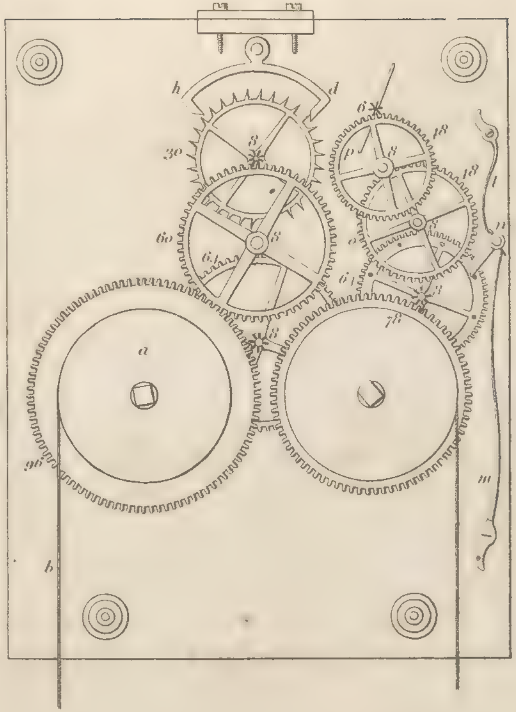
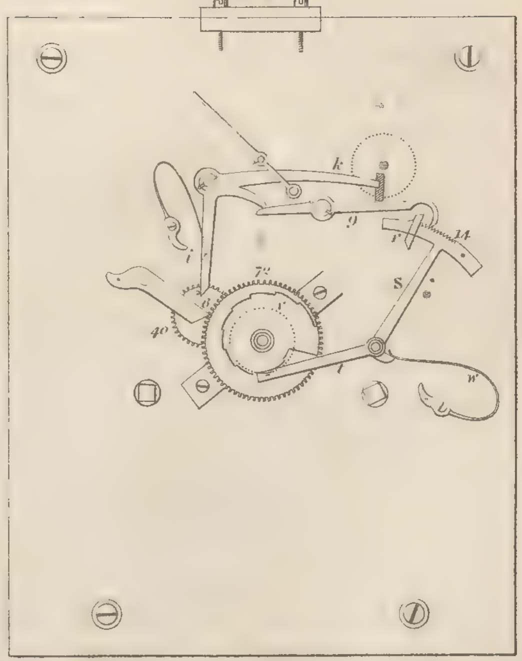


Fig. 3.



J. Farey Jun[r]. delin.

Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, March 1, 1808.

than any other man, is evidently most just, which asserts that the clock is not the invention of any one man, but an assemblage of successive inventions, each of which is worthy of a separate contriver. 1. Wheel-work, which was known in the time of Archimedes; 2. the application of the weight as a maintaining power; 3. the use of the fly as a regulator; 4. the ratchet wheel and click; 5. the substitution of the balance for the fly; and the escapement, which was necessarily introduced at the same time; 6. the application of the dial and hands; and 7. the addition of the striking part.

In the clock which was placed in a tower of the palace of Charles V. in 1364, by Henry de Wick, the regulating part consisted of a balance, which vibrated backwards and forwards by an escapement like that of common watches; it had no balance spring, but this deficiency was in some measure supplied by the mode in which it was made to move; its arbor was vertical, and instead of resting on its lower point, was suspended from above by a double cord, or cat-gut; the twisting of this cord, caused by each vibration, tended to raise the balance, and its own weight made it descend again, and at the same time turn round in the opposite direction, when the impulse of the first pallet ceased to act on it. The balance was very heavy, as weight was necessary to make it act in the above manner; and this has caused the mode of its operation to be mistaken by many, who supposed, that the cord was merely added to prevent the great friction on the lower end of the arbor, which the weight of the balance would cause.

The introduction of the spiral spring, as a first mover, instead of a weight, took place about the beginning of the sixteenth century. Mr. Peckett, of Old Compton-street, had one of this construction, which from an inscription on it in the Bohemian language, was made by Jacob Lech, of Prague, in the year 1525.

Clocks with the balances above described, imperfect as they were, gave, however, some assistance to astronomy. Tycho Brahe had four of them, but of such a massy construction, that a single wheel in one of them which had but three wheels, contained 1200 teeth, and was three feet in diameter. These clocks continued in use till about 1650, when a new æra in the art commenced, by the application of the pendulum as a regulator.

Bernard, one of the professors of astronomy at Oxford, in the last century, has asserted that the Arabians used pendulums in astronomy long before the above period, (as we know that Ricoli, Tycho Brahe, Langrenus, Vendelin, Mersenne, Kircher, Hevelius, Monton, and Galileo himself did.) in a detached state; but we do not find that any of them used it in conjunction with wheel work. According to professor Venturi, Sanctorius applied a pendulum to clock-work sometime before the year 1625; and Becker mentions a native of Switzerland, called Juste Birge, who did the same in 1597; but these experiments, if really made, never were sufficiently made public to benefit the world.

The person to whom mankind is really indebted for bringing this important discovery into universal notice, is the celebrated Christian Huygens, of Zuylichem, who in his excellent treatise "De Horologio Oscillatorio," has described the construction of a pendulum clock, and proved that he made one before the year 1658.

Galileo is supposed to have claims to the priority of the invention of the mode of applying the pendulum to clock-work, and his son Vincentio Galilei is reported (Exper. del Acad. del Cimento) to have made a pendulum clock so early as in 1649, at Venice, suggested by his father's discoveries. But it is thought that Huygens' method was much more masterly and scientific; and that the world is not under any obligation to Galileo for the invention; for, if he really made it, the manner of performing it was kept so secret, that Huygens himself never heard of it, though one of the most philosophical characters of his time. There has another claimant appeared of late years for the honour of the invention, on the authority of Mr. Thomas Grignon, of Russel-street, Covent Garden, who produces a well authenticated writing of his father's, to prove his having seen the inscription on the great clock, formerly fixed in the turret of St. Paul's, Covent Garden, which ascertained that it was made by Richard Harris, of London, in 1641. This clock was regulated by a long pendulum; and, if the above information is correct, must have been one of the first made, as it precedes that said to have been constructed by Vincentio Galilei by eight years. Mr. Grignon senior was a very ingenious mechanist, and a man of excellent character, and brought to perfection the horizontal principle in watches, and the

dead beat in clocks, which the celebrated Tompion and Graham were unable to effect. These circumstances render his testimony of considerable weight.

Huygens must, however, still be considered as the chief introducer of the invention, which no one disputes having been made by him, even though others may be supposed to have made it likewise unknown to him. He also invented a clock with a centrifugal regulator, which is contrived to perform its movement in a curve that be has demonstrated, will render its gyrations isochronal, and which, at least, is worthy of a farther investigation before it be condemned to an oblivion that it probably does not merit. But his discovery of the isochronism of all vibrations made by a pendulum formed to move in a cycloidal curve, is that which is the most noted, although it has never yet been really applied to use. Mr. Huygens' method of doing so has been shewn clearly to be erroneous, by Mr. Alexander Cummings, in his "Treatise on Clock and Watch Making," published in 1766, who has also asserted that the cycloidal principle would not be of the benefit imagined, "as the inequality of the vibrations of the pendulum moving in a circular arc, correct those caused by the alteration of its weight from the variations of atmospherical gravity, so as mutually to balance each other, while in those moving in cycloidal curves, there is no principle to counteract the variations of gravity." It must, however, be noticed, that Mr. Cummings is evidently not correct in his statement, that the loss of specific gravity in the pendulum, caused by an increase in the weight of the atmosphere, would equally tend to prolong its vibrations, as the increased resistance caused to its motion by the same means, would tend to diminish them; as he has by no means proved the equality of those opposite effects. Mr. Cummings also mistakes the loss of relative gravity, for the loss of real gravity; the momentum of a body in motion is generally considered to be the same in different mediums, except so far as the additional resistance from a denser medium retards it, and so far from Mr. Cumming's opinion in opposition to this being as evident as he supposes, it is well known that no proof has ever been advanced to support it.

Many very curious and useful theorems have been discovered relative to the pendulum, most of which originated with Huygens, among these one of the most noted is that, "The times wherein pendulums of different lengths perform their vibrations, are to one another in the same proportion with the square roots of the lengths of the pendulums.

The length of a pendulum vibrating

	Inches.	
in a second is	39.125	Halley.
	39.207	Newton.
in $\frac{1}{2}$ a second is	9.781	Halley.
	9.801	Newton.

And from these data, and the above theorem, the lengths of pendulums to vibrate any other required time may be determined.

The next improvement of consequence on clocks after the pendulum, was the escapement performed with anchor pallets, which Berthoud states to have been the invention of Clement, a London clock maker, in the year 1680. The escapement used by Huygens, and still continued in many chamber clocks and all the wooden clocks, is that made by two flat pallets attached to an horizontal arbor, acting at opposite sides of the upper part of a horizontal crown wheel; the anchor pallets on the contrary, act on a vertical swing wheel, and move in the plane of the wheel. The chief advantage of the anchor pallets is, that they will permit the escape to take place with a small angle of vibration, so as to prevent the maintaining power from acting on the pallets a long time by a direct push, as was the case with the crown wheel escapement.

Dr. Hooke also claimed the invention of the anchor escapement, which he asserted that he exhibited to the Royal Society in a clock of his construction in 1666.

At the same time with the anchor escapement, the mode of suspending the pendulum from a cock by a piece of watch spring was introduced.

The anchor escapement causes a recoil in the swing wheel, from the same face of the pallet striking the tooth of the wheel in its descent, which is afterwards impelled by the same tooth in its ascent; this occasions the clock, in which it is used, to go faster when the maintaining power is increased, or when the weight of the pendulum ball is diminished.

The advantage gained by the anchor escapement shewn above may be considered in reality an approximation to a detached escapement; a farther step was made to

wards this improvement about the year 1715, by the celebrated George Graham, in the contrivance of the dead-beat escapement, which is principally distinguished from the anchor escapement by having no recoil. This is effected by increasing the depth of the pallets in the line towards the centre of the swing wheel, and so forming the teeth of that wheel, that the pallet in action, in its descent, does not touch the teeth at all, but lies between them, and the tooth that impels it only comes in contact with its inclined plane at the instant previous to its ascent, when the opposite pallet becomes free. To avoid the wearing out of the parts most in action, and the influence of friction, the best clocks of this construction have swing wheels of hardened steel, with pallets of ruby or agate.

The detached escapement completed the improvement of this part of clock-work. Its object is to make the pendulum perform the greatest part of each vibration entirely free from contact, or connection, with any part of the train. To effect this, a catch, or locking piece, restrains all the motion of the swing wheel, till the instant when the pallet is to be impelled by it, when it raises the catch, sets the wheel free, and is driven forward by its impulse; immediately after which, the catch again falls into its place. A great variety of escapements have been contrived on this principle by various ingenious men; those in which springs are used in the locking pieces instead of pivots, invented by Arnold, seem now most preferred.

The detached escapement was applied first to chronometers, or time-pieces, but is now used for astronomical clocks. From the best accounts, Julien Le Roy invented the first about 1748; since that time, Grignon, Mudge, Cummins, Nicholson, and Arnold, have contrived various escapements of this kind in England; and Peter Le Roy, Sully, Du Tertre, De Bethune, Le Paute, Arnaut, Robin, Berthoud, &c. on the continent. See CHRONOMETER.

In the year 1715, Mr. George Graham, before mentioned, made a most material improvement in pendulums, by affixing an apparatus which tended to raise the centre of gravity of the whole as much as the lengthening of the rod by heat tended to depress it: this he performed by substituting a glass cylinder, containing mercury, for the pendulum ball. He afterwards suggested the idea of using the opposite expansions of different metals, as a compensation for the effects of variation of temperature of the air in pendulums, which was directly afterwards adopted by Harrison, at that time an obscure carpenter in the village of Barton, Lincolnshire, who surprised the world with the invention of the gridiron pendulum on this principle.

In Harrison's pendulum five bars of steel and four of brass were so arranged, that they produced two expansions of brass upwards, and three of steel downwards, so proportioned to each other, that the ascending expansions fully compensated those in the contrary direction. This pendulum has been since its invention generally used, where very accurate measurement of time was necessary. A further description of it, of Elliot's pendulum, (which was the next made on this plan, and differs little from it), and of the others here mentioned, will be inserted under the article PENDULUM.

It has been supposed by several, that the tubular pendulum, (which is also a modification of Harrison's compensation) is but a very recent invention: but the writer of this article having met with one by accident which was made upwards of thirty years ago, thinks it but justice, both to the public, and the ingenious artist who directed its construction, to oppose this opinion. This pendulum is in possession of Mr. Patoureaux, watch and clock-maker, 15, Wardour Street. It was made by Mr. William Brown, a clock-maker well known to the trade, who has been dead upwards of five years, and who formerly resided near the Seven Dials. His brother, a jeweller, residing in 15, Coventry Court, Haymarket, was his executor, and sold the pendulum to Mr. Barrett, clock-maker, of Compton Street, some years ago, from whence Mr. Patoureaux bought it. Mr. Brown, the jeweller, informed the writer that this pendulum had been made by his brother upwards of thirty years ago, just after he had served his time to Mr. Chandler, then of King Street, Seven Dials, (whom he afterwards succeeded in his business); and that it was made by direction of Mr. Chandler, who, as far as he knew, was the inventor of it: and in corroboration of this assertion, Mr. Hampson, working clock-maker, 22, Greek Street, Soho, declares, that he made several pendulums of the same construction for Mr. Brown, upwards of seven years ago. This tubular pendulum, which at present we must attribute to the ingenuity of Mr. Chandler, is composed of two tubes and a

rod of iron, and two tubes of brass. The iron rod is about a quarter of an inch in diameter, and is suspended by a spring in the common manner: it is inclosed by the first brass tube, to which it is connected at bottom: an iron tube, supported by the top of the brass tube, then descends a little below it, and supports by its lower extremity the second brass tube, which rises a little above the former tubes, and from the top of it the second iron tube descends below all about two inches into the substance of the pendulum bob, which is very large and heavy: the bottom of this last tube contains a nut, into which a screw (having a milled head beneath that sustains the bob), passes from below, and raises or lowers the bob, as required for the adjustment of the rate of going of the clock. We may date the invention of the tubular pendulum, from the foregoing information, about the year 1775, though it may yet be found to be of a still earlier period. The foreman of Mr. Villaumy, clock-maker to the Prince of Wales, Pall Mall, declares, that he remembers a tubular pendulum to have been made by Mr. Finney, a well-known clock-maker of Liverpool, upwards of forty years ago, and that it is now in the possession of Mr. De Membry, of Richmond; but time will not permit the farther investigation of this point at present.

The last modification of the longitudinal compensation made public is that of Mr. Troughton, mathematical instrument maker; it differs from Chandler's tubular pendulum, in having but two tubes of brass, which afford the ascending compensations, while the descending ones are performed by five wires of steel. The order of brass and steel is the same as in Chandler's pendulum; but all the steel wires pass downwards through the internal brass tube. The last pair of wires connect the whole with the bob by a short cylindrical piece of brass, to which the bob is suspended by its centre.

Mr. Troughton made this pendulum in July, 1804, and published the first account of it in December same year, in Nicholson's Philosophical Journal: we believe he knew nothing of the priority of Chandler's tubular pendulum to his, and that in thinking and declaring himself the first inventor of tubular pendulums, he only fell into an error common to many other ingenious men on similar occasions; and this error is the more excuseable, as at the time Chandler made his pendulum, there were no periodical works in existence which professedly recorded the improvements of arts and manufactures, and artists were in general more careful to conceal their discoveries than to acquire reputation by making them public.

Before concluding the enumeration of various sorts of pendulums, one suggested by Mr. Troughton should be noticed, which seems worthy of trial. He proposes that its rod should be made of baked potter's earth, of the same composition of Wedgewood's thermometer, and furnished with a metallic cap, by which it should be sustained by the knife-edge suspension, which the celebrated Berthoud affirms has less friction than the spring suspension.

The chief advantages which tubular pendulums have over those of the gridiron construction are, that they admit of being much lighter above the bob with equal strength; that they experience less resistance from the air in their vibrations; and that they are less liable to those shakes and irregular motions in their expansions which the others experience: on the other hand, as the outside tube alone in them comes in contact with the air through which it passes in its vibrations, the inner tubes can receive much less of its influence as to temperature, which arises from this motion, and which Cummings has shewn to be of considerable consequence. In Troughton's pendulum the great difference of the masses of matter between the ascending and descending parts must be another source of error, as the small wires of which the latter consist indubitably will much sooner experience the influence of a change of temperature in the air than the more bulky substance of the tubes. In this latter respect Chandler's tubular pendulum seems superior to Troughton's, all its parts being much more nearly of the same magnitude.

More accurate comparative trials between these gridiron and tubular compensating pendulums than any which have yet been made seem, however, necessary to determine the superiority of either; and the preference which many are now inclined to give the tubular construction seems more to arise from the greater neatness of its appearance than from any sufficient experience of its higher merit.

That it may be superior is very possible; we only aver that this has not been yet proved. But if equal apertures were made at both sides of tubular pendulums, through all the tubes, it would obviate the chief objection to them, by admitting the air to act on all their parts at once.

In the year 1803, the Society for the Encouragement of Arts gave a premium of 20 guineas to Mr. Massey, of Hornley, in Staffordshire, for a new striking part of a clock; the principal difference in which from the common movement was, that a pendulum about nine inches long, and which therefore vibrated pretty nearly half seconds, was used to regulate the interval of time between the strokes, instead of the common fly wheel. The other parts of the mechanism were also of a simpler construction than those of the striking parts of the clocks in common use.

Mr. Prior, of Nessfield, in Yorkshire, also obtained a premium from the above-mentioned society in the same year, of 30 guineas, for another contrivance for the striking part of a clock: of which the advantage consisted in the simplicity of its structure, and the precision of its performance, and which therefore possessed considerable merit as a piece of mechanism; but neither of those inventions being of any service to the great object of horological machinery, namely the precise and accurate measurement of time, we have thought a farther description of them needless here.

Clocks being considered in this point of view, as they doubtlessly should be, no great estimation can be attached at present to those clocks on the continent which were formerly so famous, whose chief object seems to have been to set a number of puppets in motion at stated times. Of these the clocks of Strasburg and of Lyons were the most noted. In the former a cock claps his wings, and proclaims the hour; and puppets, intended to represent an angel, the Virgin, and the Holy Spirit, appear: the angel opens a door, and salutes the virgin, and the Holy Spirit descends on her. In the clock of Lyons two horsemen encounter and beat the hour on each other; a door opens, and there appears on the theatre the image of the Virgin, with that of Jesus Christ in her arms; the Magi, with their retinue, marching in order, and presenting their gifts; two trumpeters sounding all the while to proclaim the procession. Clocks with chimes are of the same nature with those described.

In nearly the same rank with the foregoing must be classed the clocks made to register the motions of the heavenly bodies: they can be only considered as objects of curiosity, since in point of utility, in noting the position of the heavenly bodies, the common nautical almanacs are so superior, as to render it in some degree ridiculous to compare them together. The clock of the royal palace at Hampton Court is one of the most noted of those which have movements of this nature; but other considerations render this clock an object of great interest. According to Dr. Derham it is the oldest English clock extant, having been constructed in the year 1540, in the reign of Henry VIII. It shews the time of the day, and the motion of the sun and of the moon through all the degrees of the zodiac, together with the day of the month, the moon's southing, and other matters. These motions are the more deserving attention, as at the time the clock was made, Copernicus, then living, had not publised his book "On the Revolutions of the Celestial Orbs." And besides this, the pendulum was not applied as a regulator of clocks for nearly a century afterwards.

A few clocks have been constructed with a view directly contrary to those described, in which simplicity of parts was as much studied as great variety of movements were in the others. Of the clocks of this simple structure none have as yet exceeded that contrived by the celebrated Doctor Franklin: it shows the hours, minutes, and seconds, and yet consists of but three wheels, and two pinions. The lowest wheel contains 160 teeth, and goes round once in four hours; it carries the hand on its axle, which points out both the hours and the minutes, as will be described; and it turns a pallet above it of ten leaves, on the same axis with which is a wheel of 120 teeth, that gives motion to a pallet of eight leaves. The second hand is annexed to the same axis with this latter pallet, as also the swing wheel, which carries 30 teeth, that gives motion to the pallets of an anchor escapement, and to its pendulum that vibrates seconds. The dial of this clock is of a singular formation. The external circle on it contains 240 divisions, numbered from 1 to 60, in four successive notations. This circle shews the minutes: within it the hours are arranged in four concentric circles, or in a volute of four revolutions, along four radii, which form right angles with each other. By this arrangement, while the point of the hand shews the minute, its side exhibits the hour; or more strictly speaking, shews that the hour is one of three; but so that it will hardly ever happen that any doubt will remain of which it may be, as there are four hours difference between the figures next to each other on the same radial line. A

A small circle is placed above the great one, and divided into 60 parts for the seconds. This clock was wound up by a line going over a pulley and ratchet, on the axis of the great wheel, by which the weight was drawn up in the same manner as in the common wooden clocks. Many of these clocks have been made, which are found to measure time exceedingly well.

The small imperfection in this clock, of its leaving the uncertainty mentioned as to which of three hours it denotes, though so easily corrected by the judgment, has given rise to some ingenious contrivances to obviate it.

That of Mr. Ferguson is best known, in which the hours were engraved on the face of the lower great-wheel; the seconds on that of the upper or swing-wheel; and the minutes were shewn in a fixed dial outside all, through holes cut in which, certain small portions of the other two moveable dials were exhibited; the minute-hand was attached to the axle of the second great wheel, which contained 120 teeth, as well as the first great wheel; the swing wheel had 90 teeth, the axis of the second great wheel carries a pinion of 10 leaves, and that of the swing wheel a pinion of 6 leaves. But this clock had several imperfections, from which Dr. Franklin's clock is free. The smallness of the teeth of the swing wheel caused the pendulum to describe smaller arcs than it should do; the weight of the flat ring, on which the seconds were engraved, loaded the axis of the swing wheel, so as to cause much friction in this part, which should be as free from it as possible, and there was a considerable difficulty in adjusting the hour plate so as to correspond with the minute hand.

Another very ingenious contrivance for the same purpose has been made in a clock, on Dr. Franklin's principle, in the possession of Mr. Patoureaux, clock-maker, Wardour-street, to which the tubular pendulum, on Chandler's plan, before mentioned, is annexed. To the axis of the great wheel of this clock two concentric plates are annexed, the external one of which has a groove cut through it, along the line of a volute of four revolutions. This groove forms a trough in which a metal ball is placed, part of which is seen through its excavations. As the plate and groove turn round the ball rolls along the volute, still approaching nearer the centre as it proceeds; and when at last it arrives at the centre it falls into another trough, by which it is again conveyed to the external part of the volute; the hours are engraved between the revolutions of the volute; and the minutes are marked on an external fixed circle, to which an index, annexed to the volute plate, points. We have not been able to discover who is the author of this ingenious invention. It is certainly a superior method to Ferguson's. The moveable dial being in it annexed to the axle of least motion, where of course its weight is of least consequence; and the adjustment for the hours and minutes being performed in it at the same time. This clock is formed with a dead beat escapement, and is intended for a regulator.

The description of the parts of an eight day clock, moved by weights, inserted a little farther on, with reference to the annexed plate, may serve with a little addition to give an idea of the mechanism of a clock moved by a main spring.

The spring, by which a clock is moved, consists of a long flat plate of steel coiled up in a spiral form; it is inclosed in a cylindrical box, to which its external extremity is attached, while its internal end is connected to a fixed axis, round which the spring-box revolves. As the strength of the spring is greater the more it is coiled up by turning round the box, its action would be unequal in impelling the work of the clock; and to remedy this inconvenience the fusee wheel has been contrived. The fusee consists of a conical barrel, round which an helical groove is cut, that receives a chain or catgut, previously wound round the spring box, by which, as it is turned round, it coils up the spring; the groove receives the chain first near the base of the cone, and as the barrel revolves, gradually brings it nearer the axis; by this means the stronger the spring is coiled up the shorter is the lever by which it acts on the work; and as it gradually uncoils and becomes weaker, on the contrary the lever of action becomes longer.

If instead of the barrel, in figure 2, on which the catgut from the weight is coiled, the fusee wheel described, be supposed to be substituted, and the spiral spring, and its barrel and chain to be added, a good idea will be obtained of a spring-clock; as all the rest of the work may be the same as in the figure.

Spring-clocks are generally used in chambers, in places where weight-moved clocks would take up too much room. They are often so constructed that their frames do not hide any part of the work, and are then inclosed with glass covers, so that all their

movements may be seen; as they are designed for ornament as well as use very elegant and expensive decorations are frequently added to them.

The invention of moving time-pieces by springs first gave rise to portable time-pieces, or watches, for which see the articles CHRONOMETER and HOROLOGY.

Spring-clocks are sometimes called portable clocks, but improperly, for no pendulum clocks can be made so as to be portable: for this purpose the balance wheel and its spring must be substituted for the pendulum, and it is this point that makes the grand distinction between clocks and watches, or chronometers; the properties of the balance spring, as a regulating power, will be found in the articles before mentioned.

Clocks for astronomical purposes, in which extraordinary nicety in the exact measurement of time is necessary, have (besides the compensation pendulums, detached escapements with jewelled pallets, and other improvements before mentioned), a contrivance added to continue their movement, while the weight is winding up, which was first used in spring-moved chronometers. For this purpose a second larger ratchet wheel is added on the same arbor with that which admits the clock to be wound up, but with teeth pointing the contrary way; a strong spring, usually the greatest portion of a circle, connects this large ratchet wheel with the great wheel of the clock, which is on the same axis with it; one end of this spring being attached to the great wheel, and the other end to the large ratchet; and a catch proceeds from the inner face of the back plate to the teeth of this ratchet, which prevents its moving back when the clock is winding up, and serves as a support for the reaction of the maintaining spring. When the clock is left to the operation of the weight, the small ratchet turns round the large one and contracts, or coils up the spring till it has strength sufficient to impel the great wheel and train; and when the action of the weight is suspended, as in winding up, the spring, freed from the contracting power of the weight, expands itself and forces round the great wheel; its action in the contrary direction on the great ratchet being prevented by the catch before mentioned. Le Roy is generally supposed to have invented this improvement for his chronometers; but as he has proved that the fusee is unnecessary when a detached escapement is used, the same purpose might be answered in a much simpler manner, in those time-pieces which are moved by springs, by turning round the arbor to which the internal end of the main-spring is attached, in order to wind it up, instead of turning round the spring-box in the customary manner.

Though Le Roy was the first who contrived the spring impeller to prevent loss of time in winding up, Huygens was in reality the person with whom the idea originated; for he contrived a method by which the weight of his clock should continue to act on the train while it was drawing up; the weight in his clock having been made to draw up in a similar manner to that used in the common wooden clocks, instead of being wound up as in our metallic clocks. Patoureaux's clock has this contrivance.

The following description of an eight-day clock, with reference to the plate, will, it is hoped, sufficiently shew its construction; and the plate will, it is presumed, assist in elucidating the various parts of clocks, and improvements before described.

Plate Clock-work, is a representation of an ordinary eight-day clock, with repeating, striking mechanism.

Fig. 1, Clock-work, is an elevation of the clock sideways, shewing the pendulum and going part; the striking movements are omitted in this figure, to avoid confusion: fig. 2, is a projection of the wheel-work of both going and striking part: and fig. 3, is the dial-work, or mechanism immediately under the dial, (which is removed), and is that part which puts the striking train in motion every hour. A clock of this kind contains two independent trains of wheel-work, each with its separate first mover; one is constantly going, to indicate the time by the hands on the dial-plate; the other is put in motion every hour, and strikes a bell, to tell the hour at a distance. *a*, figures 1 and 2, is the barrel of the going part; it has a catgut band *b* wound round it, suspending the weight which keeps the clock going; 96 is a wheel, (called the first or great wheel), of that number of teeth, upon the end of the barrel, turning a pinion of eight leaves on an arbor which carries the minute-hand. 64 is a wheel of 64 teeth on the same arbor, (called the centre wheel), turning the wheel 60 by a pinion of eight leaves on its arbor; this last wheel gives motion to the pinion of eight, on the arbor of the swing wheel 30, of 30 teeth; *d*, *h*, are the pallets of the escapement fixed on an arbor *e*, fig. 1, going through the

back plate of the clock's frame, and carrying a long lever *f*; this lever has a small pin projecting from its lower end, going into an oblong hole, made in the rod B of the pendulum. The pendulum consists of an inflexible metallic rod, suspended by a very slender piece of steel-spring, D, from a brass bar, E, screwed to the frame of the clock, having a weight or bob at its lower end, in the present case 39.125 inches from the suspension D; when this pendulum is moved from the perpendicular line in either direction, and suffered to fall back again, it swings nearly as much beyond the perpendicular on the contrary side, and then returns; this it will continue to do for some time, and each of these vibrations will be performed in one second of time when the pendulum is of the above length. This is the measurer of the time; and the office of the clock is only to indicate the number of vibrations it has made, and give it a small impulse each time to keep it going, as the resistance of the air and elasticity of the spring D would otherwise in a few hours cause it to stop. By the action of the weight applied to the cord *b*, (which is called the maintaining power), the wheels are all turned round, and if the pallets *d h* were removed, the swing wheel 30 would revolve with great velocity in the direction from 30 to *d*, until the weight reached the ground; the teeth of these pallets are so made that one of them always engages the wheel, and prevents it turning more than half a tooth at a time. In the drawing, the pallet *d* has the nearest tooth of the wheel resting on it, and the pendulum is on the side *k* of the perpendicular; when it returns it moves the pallet *d*, so as to allow the tooth of the wheel to slip off; but in the mean time the pallet *h* has interposed its point in the way of the tooth next it, and stops the wheel till the next vibration or second; the distance between the two pallets *d h* is so adjusted that only half a tooth of the wheel escapes at each vibration; and as the wheel has 30 teeth, it will revolve, once in 60 vibrations of one second each, or one minute; consequently a hand on the arbor of this wheel will indicate seconds on the dial-plate F, a circle divided into 60, the pinion of eight on its arbor is turned by a wheel of 60, which consequently will turn once in seven turns and a half of the other, or in seven minutes 30 seconds, or one-eighth of an hour; its pinion of eight is moved by a wheel of 64, or eight times itself, which will turn in one-eighth part of the time, this will be an hour; the arbor of this wheel therefore carries the minute hand of the clock. The great wheel of 96, being 12 times the number of the pinion eight, will turn once in 12 hours, and the barrel *a* with it. The gut goes round 16 times, so that the clock will go eight days. The hour-hand of the clock is turned by the wheel-work shewn in fig. 3: on the end of the arbor of the centre wheel 64 a tube is fitted, so as to go round with it by friction; this carries the minute hand, but if the clock should require correction, the hand may be slipped round without moving the wheels: this tube has a pinion of 40 teeth on its lower end, indicated by a dotted circle; this turns another wheel 40, of 40 teeth, which has a pinion of six teeth on its arbor, turning a wheel 72, of 72 teeth; the two wheels 40 will both turn in an hour; and 72 in 12 hours: the arbor of this wheel has the hour-hand, and is a tube going over the arbor of the minute-hand, so that the two hands are concentric. The barrel *a* is fitted to an arbor coming through the plate of the clock, and is filed square to put on a key to wind up the weight; the great wheel 96 is not fixed fast to the arbor, but has a click on it, which takes the teeth of a rachet wheel cut upon the barrel; so that the barrel may be turned in the direction to wind up the weight without the wheel; but by the descent of the weight, the wheels will be turned by the click.

Having now described the going part of the clock, it remains to describe the mechanism by which the hours are struck. 78, fig. 2, is a great wheel of 78 teeth, with a barrel and click the same as 96; it turns a pinion of eight; 64 is a wheel on the same arbor, turning a pinion of eight on the arbor of the wheel *o* of 48, this turns another pinion of eight, and wheel *p* of 48, which turns a pinion of six, on the same arbor with a thin vane of metal, which is called the fly, and, by the resistance of the air to its motion, regulates the velocity of the wheels. The wheel 64 has eight pins projecting from it, these raise the tail *n* of the hammer, as they revolve; the hammer is returned violently when the pins leave its tail, by a spring *m* pressing on the end of a pin put through its arbor, and strikes the bell, (the hammer and bell are behind the plate, and therefore unseen,) *l* is a short spring which the other end of the pin through the arbor touches, just before the hammer strikes the bell, its use is to lift the hammer off the bell the instant it

has struck, that it may not stop the sound. The eighth pin in the wheel 64 must pass by the hammer tail 78 times in striking the 12 hours, $1+2+3+4+5+6+7+8+9+10+11+12=78$, and as its pinion has eight leaves, each leaf of the pinion answers to a pin in the wheel 64; now as the great wheel has 78 teeth, it will turn once in 12 hours, the same as the other great wheel 96. In the wheel 64 eight of its teeth correspond to one of the pins for the hammer, and as the pinion of the wheel *o* has eight teeth, it (wheel *o*) will turn once for each stroke of the hammer. By the remaining wheels, one, *o*, multiplying six, and the other, *p*, eight times, the fly will turn $6\times 8=48$ times for one turn of o = one stroke of the hammer. Fig. 3 is also mechanism relating to the striking part: *r* is a small pinion of one tooth, called the gathering pallet, on the arbor of wheel *o*, and consequently turns once for each stroke of the hammer; *s* is a segment of a large wheel which it turns, (called the rack); *t* is an arm attached to the rack, whose end rests against a spiral plate, V, called the snail; this is fixed on the tubular arbor before described of the hour hand and wheel 72, and turns round with it once in 12 hours. The plate is divided into 12 equal angles, 30 degrees each, and as it turns, each of these answers to an hour; the circular arcs forming the circumference of the snail are struck from the centre of the arbor between each division with a different radius, decreasing a certain quantity each time in the order of the hours. The circular part of the rack *s* is cut into teeth, each of which is of such a length, that every step upon the snail shall answer to one of them; *w* is a spring pressing against the tail of the rack, and acting to throw the arm of the rack against the snail; *g* is a click called the hawk's bill, taking into the teeth of the rack, and holding it up in opposition to the spring *w*; *i k* is a three-armed detent, called the warning piece, the arm *k* is bent at its end, and passes through a hole in the front plate of the clock, so as to catch a pin placed in one of the arms of the wheel *p*, fig. 2, and which describes the dotted circle in fig. 3, the other arm *i* stands so as to fall in the way of a pin in the wheel 40. In the present position of the figure, the wheels of the striking train are in motion, and would continue turning until the gathering pallet *r*, which turns once at each stroke of the hammer, by its tooth lifts the rack *s* in opposition to the spring *w*, one tooth each turn, and the hawk's bill *g* retains the rack, until a pin in the end of the rack is brought in the way of the lever of the gathering pallet *r*, and stops the wheels from turning any further: it is in this position with the rack wound up, till its pin arrests the tail *r*, that we shall begin to describe the operation of the striking of the clock. The wheel 40, as we have said before, turns once in an hour, and consequently at the expiration of every hour the pin in it takes the end *i*, and moves it towards the spring near it, this depresses the end *k* until it falls in the circle of the motion of the pin in the wheel *p*, fig. 2, at the same time the short tail depresses one end of the hawk's bill, and raises the other *g*, so as to clear the teeth of the rack *s*; immediately the spring *w* throws the rack back, until the end of its tail *t* touches that part of the snail which is nearest it; when the rack falls back, the pin in it is moved clear of the gathering pallet *r*, and the wheels set at liberty; the maintaining power puts them in motion; but in a very short time before the hammer has struck, the pin in the wheel *p* falls against the end of *k* and stops the whole: this operation happens a few minutes before the clock strikes, and this noise of the wheels turning is called the warning; when the hour is expired, the wheel 40 has turned so far as to allow the end of *i* to slip over its pin, as in the figure; the small spring pressing against it raises the end *k* so as to be within the circle of the pin in the wheel *p*, fig. 2: every obstacle is now removed, and the wheels run on the pinion; the wheel 64 raises the hammer *r*, and it strikes on the bell, the gathering pallet *r* takes up the rack, a tooth at each turn, the hawk's bill *g* retaining it until the pin in the rack comes under the gathering pallet *r*, and stops the motion of the whole machine, till the pin in the wheel 40 at the next hour takes the warning piece *i k*, and repeats the operation we have now described. As the gathering pallet turns once for each blow of the hammer, and its tooth gathers up one tooth of the rack at each turn, it is evident the number of teeth the rack is allowed to fall back limits the number of strokes the hammer will make. This is done by the rack's tail *t* resting on the snail; each step of the snail answers to one tooth of the rack, and one stroke of the hammer; at each hour a fresh step of the snail is turned to the tail of the rack, and

by this means the number of strokes is made to increase one at each time from one to twelve.

CLOCK-*work*, in the limited meaning of the word used by artists, denotes only the machinery employed in the striking part of a clock; that used for giving motion to the hands being called watch-work. In its more extensive sense, it is generally understood to mean any combination of wheel-work, for any purpose, whose parts do not much exceed in size those of a common clock.

CLOSE, in heraldry. When any bird is drawn in a coat of arms with its wings close down about it (*i. e.* not displayed) and in a standing posture, they blazon it by this word close; but if it be flying, they call it volant.

CLOSE *hauled*, in marine language, the arrangement of a ship's sails when she endeavours to make progress in the nearest direction possible towards that point of the compass from which the wind blows; in this manner of sailing the keel of square rigged vessels commonly makes an angle of six points with the line of the wind, but cutters, luggers, and other fore and aft rigged vessels will sail much nearer.

CLOSE *quarters*, strong barriers of wood stretching across a merchant ship, in several places; they are used as a place of retreat when a ship is boarded by her adversary, and are therefore fitted with loopholes, through which to fire the small arms. An English merchant ship of 16 guns, properly fitted with close quarters, has defeated the united efforts of three French privateers who boarded her.

CLOTH, a woven fabric composed of wool, flax, cotton, or hemp, either separate or mixed. Woollen cloths consist chiefly of broad cloths, kerseymeres, flannels, shalloons, serges, baizes, &c.: the two former are the most valuable, and will be chiefly noticed. The wool should be of the best quality, and in the best state of preparation before it is sent to the loom. Formerly Spanish wool bore a very high price with us, but of late years we have, by obtaining some of the sheep of that country, established a breed which is found to yield a finer sample than even the pure Marino. The justly celebrated Dr. Parry, of Bath, has sedulously attended to this point, and has produced fleeces which, in regard to fineness and length of staple, are obviously superior, being as six to five when compared with the Spanish. Hence our woollens have latterly been less indebted to importation, and we may fairly expect to see our flocks become doubly valuable. The cloths are woven in a common loom, and the superfluous nap is taken off by a very ingenious contrivance called the shearer, not unlike the blade of a scythe, which with a regular motion, given by various machinery, completely levels the surface, and fits it for the last process; this is done by the teazel, a kind of thistle, which grows in hedge rows, but is in many parts cultivated for the supply of manufactories. The heads of the teazles are inserted into grooves in long battens, so as to appear, and to act like brushes; these brushes extend the whole breadth of the cloth, and are set all around a cylinder, which brushes the cloth by its rotatory motion, rendering its surface beautifully glossy and smooth. The appearance is, however, greatly improved by pressing. The coarser kinds of cloth undergo little finishing. Linens are made of bleached flax; they are chiefly manufactured in Ireland and Scotland, both which countries derive essential advantages from their manufactures, especially as they produce the raw material. Cotton must be imported in its raw state; a circumstance which gives employ to many thousands of our poor. Though the muslins, calicos, &c. are generally made from the thread formed by machinery. Hemp makes SAIL-CLOTH, CANVAS, &c. which see. The manufactories for woollens and linens in the United Kingdoms, are supposed to give bread to near a million of persons. The importation of foreign cloths is therefore very wisely prohibited. For further particulars see WEAVING.

CLOUD, a visible aggregate of minute drops of water, suspended in the atmosphere. It is concluded, from numerous observations, that the particles of which a cloud consists, are always more or less electrified. The hypothesis, which assumes the existence of vesicular vapour, and makes the particles of clouds to be hollow spheres, which unite and descend in rain when ruptured, however sanctioned by the authority of several eminent philosophers, does not seem necessary to the science of meteorology in its present state; it being evident that the buoyancy of the particles is not more perfect than it ought to be, if we regard them as mere drops of water. In fact they always descend, and the

water is elevated again only by being converted into invisible vapour. See METEOROLOGY.

CLUE, in marine language, is the lower corners of square sails; but the aftmost only of stay-sails, &c.; the other lower corner being called the tack.

CLUES of a hammock, the combination of small lines by which it is suspended.

CLUPEA, the *herring*, in natural history, a genus of fishes of the order Abdominales. Generic character: head compressed; mouth compressed and internally rough; jaws unequal; tongue short and rough; with inverted teeth; side-plates of the upper mandible serrated; gill-membrane eight-rayed; gills setaceous internally; abdomen sharp and generally serrated; body compressed, elongated, and covered with moderate scales; ventral fins often nine-rayed; tail forked. There are fifteen species, according to Gmelin, and according to Shaw, nineteen; of which the most deserving of notice are C. harengus, or the common herring.

This fish does not appear to have been known by the Greeks and Romans, or at least to have attracted from them any particular attention. In modern times it constitutes an important article of commerce, and the herring fishery has for ages been considered as an important field for national industry, and a source of national wealth. Even in the twelfth century the Dutch were much occupied in taking herrings, and preserved a sort of monopoly on this subject for several ages. The art of pickling them was discovered in Flanders. The Dutch are uncommonly partial to the pickled herring, and on the arrival of the first vessel in port, laden with this article, resort to it with all the ardour of impatience and competition. This first vessel also is entitled to a considerable premium. The term herring is derived from a German word, meaning an army, and well expresses the immense multitude of this fish, which, after wintering within the arctic seas, where insect food abounds fully to the extent of their immense demands, direct their course in spring towards the south. In April they are generally seen off the isles of Shetland, and their progress is marked by the flocks of birds which accompany them, and prey upon them. There are, in general, several columns of this mighty host, extending about five miles in length and three in breadth, and reflecting, by their advance to the very surface of the water, that pearly lustre and lively variety of colour which, in clear weather, give to the spectacle extraordinary interest. From the Isles of Shetland they divide to the eastern and western shores of Great Britain; in the former case passing through the English Channel, after visiting every gulf and creek within its limits; in the latter, visiting the coast of Ireland, and furnishing the inhabitants with a cheap and valuable article of subsistence. Some naturalists, however, have doubted of the extensive migrations ascribed to the herring, and consider the time allotted for its accomplishment as totally inadequate for this purpose. They suppose them in winter to shelter themselves in the profound retreats of the ocean, and amidst its soft and muddy bottoms, near those very shores, in their approach to which they are first seen in spring. The food of the herring consists chiefly of sea-insects and worms, and itself becomes food, not only, as before intimated, to various birds who follow their track with unceasing vigilance and voracity, but to innumerable fishes also: of these the whale is its most formidable enemy, and thins its columns with the most destructive and consuming havock.

The C. pilchardus, or the pilchard. This is somewhat smaller than the last; its scales also are larger; and its body is thicker, rounder, and more oily. It abounds in the summer months on the coast of Cornwall, and in the port of St. Ives nearly two hundred and fifty millions were once inclosed by a single draught. The supply of this fish being very frequently far superior to any regular demand, it has in some cases been employed merely as manure, for which it is found admirably applicable.

C. alosa or shad. This is considerably like the pilchard; but is larger and thinner; distinguishable particularly by the scales upon its belly, which form a sharp keel along it. It is found in the Mediterranean and in the Baltic, and ascends rivers periodically to deposit its spawn, which it always does in the deepest parts. The longer it continues in fresh water, the fatter it becomes; it feeds principally on insects and young fish, and can live but a few moments after being taken from the water. It is little valued for the table, being coarse and tasteless. It is found in the rivers of England, and principally in the Severn.

C. sprattus, or sprat, resembles the herring, and might easily be taken for its young. There are, however, decided differences. During the winter months sprats

are caught in abundance in the Thames, and are a very valuable resource for the poor inhabitants of the metropolis. In some places they are pickled with great advantage; in others they are cured like the herring, and are scarcely less relished.

C. encrasicolus, or anchovy. This was well known to the ancients, who prepared from it a sauce in high estimation. Its bones are soluble in boiling water, which renders it of great convenience in condimental preparations.

CLUSIA, in botany; so called in memory of Carolus Clusius, an eminent French botanist: a genus of the Polygamia Monoecia class and order. Natural order of Guttiferæ, Jussieu. Essential character: male, calyx four or six-leaved; leaflets opposite, imbricate; corolla four or six-petalled; stamina numerous: female, calyx and corolla as in the males; nectary formed by the coalition of the anthers, including the germ; capsule five-celled, five-valved, stuffed with pulp. There are six species. These are trees abounding in a tenacious, glutinous juice. C. rosea, rose-coloured balsam-tree, is from twenty to thirty feet in height, a native of the Bahama Islands, St. Domingo, and other American islands, between the Tropics, on rocks, and often on the trunks and limbs of trees, occasioned by birds scattering or voiding the seeds, which being glutinous like those of misletoe, take root in the same manner; but the roots, not finding sufficient nutriment, spread on the surface of the tree till they find a decayed hole or other lodgment, where there is some portion of soil; the fertility of this being exhausted, a root is discharged from the hole till it reaches the ground, though at forty feet distance; here again it fixes itself, and becomes a larger tree.

CLUYTIA, in botany, in memory of Augerius Clutius, professor of botany at Leyden, a genus of the Dioecia Gynandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; female, styles three; capsule three-celled; seed one. There are ten species, all natives of hot climates.

CLYPEOLA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ. Cruciferæ, Jussieu. Essential character: silicle emarginate, or biculate, compressed, flat, deciduous. There are three species. These are low plants that have little beauty, and are preserved chiefly in botanic gardens.

CLYSTER is a liquid remedy to be injected chiefly at the anus into the larger intestines.

CNEORUM, in botany, a genus of the Triandria Monogynia class and order. Natural order of Tricoccæ. Terebintaceæ, Jussieu. Estential character: calyx three-toothed; petals three, equal; berry tricoccous. There is but one species; *viz.* C. tricoccum, willow-wail, or spunge olive; native of the South of France, Italy, and Spain, in hot, dry, barren, and rocky soils.

CNICUS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx ovate, imbricate with branch-thorny scales, guarded with bractes; corollets equal. There are nine species.

COACH, a convenient carriage suspended on four or more springs, and moving on four wheels, originally intended for the conveyance of persons in the upper circles of society, but now become so common as to stand in our streets plying for fares. The first coach ever seen in England was introduced by the Earl of Arundel from the continent, in the year 1581; since that time their numbers have been gradually increasing, insomuch that every family of easy fortune keeps its carriage; while no less than 1100 hackney coaches are registered within the bills of mortality. See Coaches, *hackney*. Such coaches as are the property of private persons, or are kept for hire, pay a high duty, and produce a total of several hundreds of thousands to the Exchequer. The fashions, with regard to form and ornament of coaches and other carriages for pleasure, are perpetually changing, and many varieties are occasionally presented. The principal kinds now in use are the close coach; the landau, which can lower its roof and part of its sides, like the head of a phaeton; the barouche, or open summer carriage, made on the lightest construction; the chariot, which is intended only for two or three persons; the landaulet, or chariot whose head unfolds back; the phaeton and caravan, which have only a head and no windows, with a leather apron rising from the foot-board to the waist: all of these run upon four wheels. Of the two-wheeled vehicles we have the curricle, drawn by two horses, each bearing on a narrow saddle the end of a sliding bar

or yoke, that upholds a central pole. These cannot be considered as very safe machines, but are admirably calculated for ease of draught; and, their bodies being upon four pliant springs, must generally have a very easy motion. The gig, chaise, or whiskey, has but one horse, which moves between a pair of shafts, borne nearly horizontal by means of a leather sling passing over the saddle tree; when another horse precedes, so as to drive one before the other, the machine is called a tandem; a pun upon that word, which in Latin signifies "at length." Those chaises which do not go upon springs, and are in other respects calculated for the use of the poorer classes, pay less duty, but must bear the words "taxed cart" in some conspicuous part, and in letters of not less than an inch in depth: their cost must also be under 12*l.* Our stage-coaches which travel to every part of the kingdom, are, beyond compare, superior to those of any other nation both for speed of travelling and accommodation. The legislature has wisely restricted the numbers of inside and of outside passengers. On the whole, they perform their journies at the rate of 5 miles in the hour during summer, and about 4½ during the winter season. Taken on an average, the rates are from 4½*d.* to 6*d.* per mile for inside passengers; though in cases of competition they have gone so low as 2*d.* The mail-coaches, which carry the letters to and from the General Post-Office, are of a very strong build, and usually run 8, or even 9 miles within the hour; they are limited as to the time in which each stage is to be performed; and the guard makes remarks as to the condition of the cattle, the performance of their duty, the accidental delays and deviations, upon a printed way-bill delivered with the bags at the post-office; he notes every matter relating to time, according to his timepiece, which is always adjusted before he takes leave. The mail-coaches are restricted to four inside and two outside passengers, besides the coachman and the guard, both of whom wear the king's livery; and the royal arms are borne upon the centre pannels of the coach. All the mail-coaches pass in review at Buckingham House, and St. James's, on his Majesty's birth-day; the guards and drivers dressed in their new uniforms, and the horses decked with ribbons. Every mail-coach, so soon as it arrives in town, is sent to the Overseer and Contractor at Mill-Bank, Westminster, where it is strictly examined, the screws tightened, axles greased, and every precaution taken to guard against accident.

Coaches, *hackney:* commissioners are appointed to license and regulate them: the proprietor of each coach to pay 10*s.* per week. Each coach is to be numbered on both sides, the altering of which incurs a penalty of 5*l.* The same penalty is incurred by driving or letting to hire a coach without a license. Mourning-coaches and hearses are within the act. The horses in hackney-coaches must be fourteen hands high. Coachmen compellable to go in the day ten miles; after dark but two miles and a half on turnpike-roads; to have check-strings, under the penalty of 5*l.*

The rate for a mile and a quarter, or less, is 1*s.* from that to two, 1*s.* 6*d.* and for each additional half mile entered upon, 6*d.*

In reckoning by time, three quarters of an hour, or less, is 1*s.* between that and an hour 1*s.* 6*d.* one hour and twenty minutes 2*s.* and for each additional twenty minutes entered upon 6*d.* For a day of twelve hours, 14*s.* 6*d.* and 6*d.* for each twenty minutes over.

A coachman refusing to go, or exacting more than his fare, forfeits from 10*s.* to 3*l.* By misbehaviour or impudence he incurs the same penalty, and subjects his license to be revoked, and himself to be committed to the house of correction. Persons refusing to pay the fare, or defacing the coach, may be compelled by a justice to make satisfaction. The penalties may be recovered before the aldermen of the city, and justices of the peace, as well as before the commissioners. 4, 7, 10, 11, 12, 24, 26, and 32, Geo. III.

Coaches, *stage:* every person keeping any public stage-coach shall pay, annually, 5*s.* for a license; and keeping any such public stage without a license, he shall forfeit for every time such carriage is used 10*l.* No person licensed shall, by virtue of one license, keep more than one carriage, on penalty of 10*l.* Every licensed stage-coach shall pay 2½*d.* for every mile it travels. Every person licensed shall paint, on the outside pannel of each door, his christian and surname, with the name of place from whence he sets out, and to which he is going, on pain of 10*l.* Should he discontinue such carriage he shall give seven days previous notice, and have such notice indorsed upon his licence, and from thenceforth shall be no longer chargeable.

Drivers of stage-coaches are not to admit more than one outside passenger on the

box, and four on the roof of the coach, on the penalty of 5*s*. for each passenger at every turnpike-gate.

COADUNATÆ, in botany; the 52d order of plants in Linnæus' "Fragments of a Natural Method," so named from the general appearance of the seed-vessels, which are numerous, and being slightly attached below, form altogether a single fruit in the shape of a sphere or cone, the parts of which are easily separated from one another.

COAGULATION, is the property of certain liquids becoming solid without evaporation, and without their assuming a crystalline form. The hardening of the white of an egg, by mere heat, is an example of this kind: the characteristic properties of the substance are completely changed. In their first state it is soluble in water; but coagulated, water neither hot nor cold has any power over it. See ALBUMEN.

COAL, in mineralogy, a most important genus of mineral inflammables, in which is included the carbonaceous, and carbono-bituminous fossils. In the excellent dictionary by Messrs. A. and C. Aikin, this genus is divided into the families of brown coal, black coal, and mineral carbon. The first, or brown coal, is imperfectly bituminous, of a brown colour and vegetable texture: of this there are four species. The second, or black coal, is perfectly bituminous, of a black colour, and contains three species, of which one is the slate coal, which is soft and easily frangible: specific gravity 1.2 to 1.24: it contains from 57 to 64 of carbon, and from 33 to 43 of bitumen, being a mixture of maltha and asphalt, and from 3 to 6 of earth and oxide of iron. Most of our common coals belong to this species, and from the different phenomena which they exhibit during combustion, a great number of varieties are known in the market. The canal coal is of this family. See AMPELITES. The third sort, or mineral carbon, is destitute of bitumen, and consists of charcoal with various proportions of earth and iron. There are three species, of which one is plumbago, or black-lead. See BLACK-LEAD.

Coal, of all the substances which naturalists have arranged in the class of inflammables, is by far the most serviceable to mankind. Nature has dealt it to us with an unsparing hand, and has provided mines of this mineral which seem to defy the power of man to exhaust. England and France, where the different branches of manufacture are carried to a greater extent and perfection than in the other countries of Europe, are, at the same time, the most abundantly provided with mines of coal, as if nature was determined to second the exertions of an industrious people by giving them the best possible assistance. Coal is always found in masses, sometimes in a heap, most frequently in beds; but rarely in veins. The beds are disposed within the earth with different degrees of inclination, and in almost every possible direction. These beds of coal are supposed by most naturalists to be a deposit formed by the waters of the ocean, which once covered our continent. They are never found single, but generally disposed in strata one above another. The beds of coal are separated by layers of stone, which are nearly of the same nature in all coal mines. Those which form the side and the top of a stratum of coal are a sort of friable slate, containing more or less of bitumen, while the bottom is generally more compacted and mixed with micaceous sand. It is remarkable that this slaty kind of stone, which so generally accompanies the coal, should frequently contain the impressions of plants, and particularly ferns, some of which are met with in the finest state of preservation.

In Scotland, the mines of Carron, of Edinburgh, and of Glasgow, are chiefly distinguished for their produce. There are three beds of coal at Carron, the first of which is about 40 fathoms below the surface, the second 50, and the third 55. Only two beds are worked at Edinburgh, and one of them is remarkable for its situation, the opening of the mine being hardly forty fathoms from the sea, and only three fathoms above high water mark. The mines of Glasgow stretch from the north-east to the south-west, and occupy a considerable space of ground. Here are several beds of coal, placed on each other and continued nearly from the surface of the ground to the depth of three hundred feet; but of these beds there are only two or three that are worth the trouble of working.

The principal mines of this useful mineral in England are those of Newcastle and Whitehaven. The town of Newcastle absolutely stands on beds of coals, which extend to a considerable distance round the place. There are seven or eight beds of this mineral, one above the other, and all inclined in a south-east direction; the lowest is a hundred fathoms from the surface of

the earth. But the mines near Whitehaven will afford the best idea of these wonderful places. We learn that these coal mines are perhaps the most extraordinary of any in the known world. The principal entrance for men and horses is by an opening at the bottom of a hill, through a long passage hewn in the rock, which, by a steep descent leads down to the lowest vein of coal. The greatest part of this descent is through spacious galleries, which continually intersect each other; all the coal being cut away, except large pillars, which, in deep parts of the mine are three yards high, and twelve square at the base. The mines are sunk to the depth of a hundred and thirty fathoms, and are extended under the sea to places where, above them, the water is of sufficient depth for ships of large burthen. These are the deepest coal mines that have hitherto been wrought, and perhaps the miners have not in any other part of the globe penetrated to so great a depth below the surface of the sea; the very deep mines in Hungary, Peru, and elsewhere, being situated in mountainous countries, where the surface of the earth is elevated to a great height above the level of the ocean. There are here three strata of coal, which lie at a considerable distance, one above another; the communication between each is preserved by pits. The vein is not always regularly continued in the same inclined plane, but is sometimes interrupted by hard rocks, and in those places the earth seems to have sunk downwards from the surface, while the part adjoining hath retained its ancient situation. These breaks the miners call dykes, and when they meet with one of them, they first observe whether the direction of the strata is higher or lower than in the part where they have been working. If, to employ their own terms, it is cast down, they sink a pit to it with little trouble; but should it, on the contrary, be cast up to any considerable height, they are frequently obliged to carry a long level through the rock with much expense and difficulty, till they again arrive at the vein of coal.

In these deep and extensive works, the greatest care is requisite to keep them continually ventilated with perpetual currents of fresh air, to expel the damps and other noxious exhalations, and supply the miners with a sufficiency of that vital fluid. In the deserted works, large quantities of these damps are frequently collected, and often remain for a long time without doing any mischief; but when, by some accident, they are set on fire, they produce dreadful and destructive explosions, and burst out of the pits with great impetuosity, like the fiery eruptions from burning mountains. The coal in these mines hath several times been set on fire by the fulminating damp, and continued burning many months until large streams of water were conducted into the mines, and suffered to fill those parts where the coal was on fire. Several collieries have been entirely destroyed by such fires: of these there are instances near Newcastle, and in other parts of England, and in the shire of Fife in Scotland; in some of which places the fire has continued burning for ages. To prevent as much as possible the collieries from being filled with these pernicious damps, it has been found necessary to search for those crevices in the coal whence they issue, and then confine them within a narrow space, from which they are afterwards conducted through long tubes into the open air, where, being set an fire, they consume in perpetual flames, as they continually arise out of the earth. The late Mr. Spedding, who was the great engineer of those works, having observed that the fulminating damp could only be kindled by flame, and was not liable to be set on fire by red hot iron, nor by the sparks, produced by the collision of flint and steel, invented a machine, in which, while a steel wheel is turned round with a very rapid motion, flints are applied to it, and by the abundance of fiery sparks emitted, the miners are enabled to carry on their work in places where the flame of a lamp or candle would occasion dreadful explosions. Without some invention of this sort, the working of these mines would long ago have been impracticable, so greatly are they annoyed by these inflammable damps. Fewer mines, however, have been ruined by fire than by inundations; and here that noble piece of mechanism the steam-engine displays its beneficial effects. When the four engines belonging to this colliery are all at work, they discharge 1228 gallons of water every minute at thirteen strokes; and, after the same rate, 1,768,320 gallons every twenty-four hours.

The road from the Whitehaven coal-mines to the water side is mostly on a gentle descent, and provided with an iron railway; this, by removing much of the friction, exceedingly facilitates the carriage of the coals to the shipping, which are laid alongside

of the quay to receive them. When the waggons are loaded, they run without any assistance on the railway till they arrive at the quay, where the bottom striking out, the waggon discharges its contents into a large flue, or, as the workmen term it, a hurry, through which it rattles into the hold of the vessel with a noise like thunder. A man is placed in each waggon to guide it, who checks its progress, if necessary, by pressing down one of the wheels with a piece of wood provided for the purpose. When the waggons are unloaded, they are carried round by a turn-frame, and drawn back to the pits by a single horse along another road. The coal trade is supposed to maintain nearly 15,000 mariners, and to employ about 2000 coal-heavers, who are allowed a fixed sum on clearing each ship, according to her tonnage. These are supposed to be the hardest working men in the kingdom: they often earn six, seven, or eight shillings in the day; of which at least one-third; or perhaps one half, is spent in porter. By a late act coals are permitted to be landed at Paddington, in the parish of Mary-le-bone, not, however, exceeding a specified quantity within the year. These coals come by the canals from the inland counties, generally in large masses, and free from coal-dust. A patent has been granted within these few years for the formation of coal-dust into balls, which are compacted by the admixture of soft clay, tanner's bark, and various other materials, all of which tend to swell the mass, and form a tolerable fuel: it brings much rubbish to an excellent use. A patent was also granted about 20 years back to Lord Dundonald, for making tar from coal. This tar has been found to answer many useful purposes, being an admirable coating for wood or other work exposed to the weather; but, on account of its being peculiarly subtile, must be carefully kept away from articles of provision, to which it communicates a most unpleasant, bituminous flavour. The cinders and ashes from coal are in much estimation as manure for particular soils, and are highly obnoxious to worms. They are likewise employed in the making of bricks.

There are different opinions among geologists respecting the origin of coal. Some suppose this combustible substance to be produced by the decomposition of the soft parts of the immense quantity of organized bodies of which we find almost every where the solid remains. But unfortunately this conjecture, which appears so natural, is liable to several strong objections. One is the presence of vegetables scarcely decomposed, which are often met with in the middle of beds of coal. The others, the want of direct experiments to prove that organized bodies give out bitumen during their decomposition. Without stopping to discuss these points, we shall merely give the general conclusions of naturalists, as they are mentioned by Brogniart. 1. That coal was formed, either at the same time, or after the existence of organized bodies. 2. That this mineral when first formed was liquid, and of a great degree of purity. 3. That the cause which produces this deposit is several times renewed in the same place, and nearly under the same circumstances. 4. That the cause, whatever it may be, is nearly the same over all the earth, since the beds of coal always exhibit nearly the same phenomena in their structure and accidental circumstances. 5. That these beds have not been deposited by any violent revolution; but, on the contrary, in the most tranquil manner; since the organized bodies that are found in them are often entire, and the leaves of vegetables impressed in the slate which covers the coals are hardly ever bruised, or otherwise deranged.

COASTING, that part of navigation where the places assigned are not far distant, so that a ship may sail in sight of land, or within soundings between them. In this there is only required a good knowledge of the land, the use of the compass and lead, or sounding line.

Coasting *pilot*, one who, by experience, has become sufficiently acquainted with the nature of any particular coast to conduct a ship or fleet from one part of it to another.

COAT *of arms*, in heraldry, a surcoat reaching to the waist, open at the sides, and ornamented with armorial bearings, worn by the ancient knights in times of war, or at tournaments, over their armour, being the principal characteristic by which they were distinguished from one another, the face being covered with the helmet. During the period of five centuries after the conquest, the variation in the mode of exhibiting coat-armour was very trivial.

The Norman in the field being closely invested in armour which exactly fitted his shape, threw over it an ornamented surcoat without sleeves, at first loose; but during the successive reigns of the three first Edwards, it was confined to the body in narrow folds. After that the mixed armour

(composed of mail and plates) became common, and the steel boddice was gilt and otherwise ornamented. This armour did not, however, long continue in fashion, but was succeeded by tabards of arms larger than the original surcoat, and made of the richest silk stuffs, sumptuously embroidered; which afterwards became the dress worn by the nobility and gentry, till the commencement of the sixteenth century: since that time they have been continued only as the state dress of the officers of arms.

COATS, in a ship, are pieces of tarred canvass put about the masts at the partners to keep out water. They are also used at the rudder's head, and about the pumps at the decks, that no water may go down there.

COATING, in chemistry, is used principally for the purpose of defending certain vessels from the immediate action of fire; thus, glass retorts, and the inside of some furnaces, are coated with various compositions.

COATING, in electricity, means the covering of electric bodies with conductors, or the latter with the former, or, lastly, electrics with other electrics. Electrics are coated with conductors for the purpose of communicating to, or removing from their surfaces, the electric fluid in an easy and expeditious manner; otherwise an electric body, on account of its non-conducting property, cannot be electrified or deprived of the electric fluid without touching almost every point of its surface with an electrified or other body. This coating generally consists of tin-foil, sheet-lead, gilt paper, gold-leaf, silver leaf, or other metallic body, either in the form of a thin extended lamina, or in small grains, such as brass filings and leaden shot. The coating may be fastened to the surface of the electric by means of paste, glue, wax, or other adhesive matter.

COBALT, in chemistry, a metal, when pure, of a white colour, inclining to bluish or steel grey. At the common temperature its specific gravity is more than 8.5. It is attracted by the magnetic needle, and is itself capable of polarity. For fusion it requires nearly the same intensity of heat as cast iron. In a state of oxide, it tinges the saline vitreous fluxes of a deep blue colour. It is soluble in nitro-muriatic acid, and the diluted solution forms a blue sympathetic ink. Cobalt occurs in nature alloyed with other metals, and mineralized by oxygen, and by arsenic acid. The white cobalt ore is an alloy of cobalt and arsenic, with a little sulphur, and in some specimens a little iron, the two latter being probably accidental. One variety, analyzed by Klaproth, gave 44 of cobalt, 55.5 of arsenic, and 0.5 of sulphur. Its colour is tin-white, liable, however, to tarnish, and thus to assume a grey or reddish tinge; its lustre is weakly shining and metallic.

The grey cobalt ore, as it has been named, is an alloy of cobalt with arsenic and iron; sometimes, also, as has been affirmed, with small portions of nickel and bismuth. Its colour is light grey, but very liable to tarnish; its lustre weakly shining and metallic. Exposed to the flame of the blow-pipe, it gives an arsenical odour and smoke, but without melting: to borax it gives a blue colour, and is reduced to a metallic globule. The native oxide of cobalt occurs in a powdery form, or of various degrees of induration, but always dull, and earthy in its fracture, soft, and easily broken. It is also of different colours, from the intermixture of oxide of iron, and perhaps other metallic oxides; whence even species have been formed and distinguished by the names of black cobalt ochre, brown cobalt ochre, and yellow cobalt ochre. Of these the black appears to be the oxide of cobalt in its purest state. They all give a blue colour to glass, or to borax when fused with it by the blow-pipe. Sometimes also they exhale an arsenical odour. The last species is that in which cobalt is mineralized by arsenic acid, the principal variety of which has been named peach-bloom cobalt ore. This name it derives from its colour, which is a beautiful red, similar to that of the peach blossom, passing, however, into other shades of red, and from decomposition into other colours. The ores of cobalt are easily distinguished from all others, by their property of communicating to borax or to glass, when fused with them, a deep blue colour, and by their solution in nitro-muriatic acid being a sympathetic ink, lines traced with it on paper not being visible when cold, but becoming visible on exposure to a moderate heat.

On a large scale, cobalt is extracted from its ores only in the state of an oxide, without being reduced to the metallic form, not only as this reduction is difficult, but also as the metal is not applied to any use. The ore is roasted, by which the sulphur and arsenic are expelled, and any fusible metal mixed with it is melted out. The cobalt remains in the state of an impure oxide,

named zaffre. The zaffre of commerce is always mixed with silicious earth; hence, if exposed to a strong heat, it vitrifies: a glass of a dark blue colour is thus formed, named smalt, which is used on account of its colour in various arts. It is from the zaffre of commerce that the chemist obtains cobalt: to obtain it pure, however, is extremely difficult. The common process is to mix the zaffre with three times its weight of black flux, a small quantity of oil, and a little sea salt, and expose the mixture in a crucible to a strong white heat for some hours. A metallic button is thus obtained, on cooling, at the bottom of the crucible; but the cobalt procured is generally alloyed with arsenic and nickel, and sometimes with other metals, particularly iron.

A number of the acids oxydize cobalt, and combine with its oxyde. The concentrated sulphuric acid scarcely acts on it in the cold, but, when boiled on the metal, sulphurous acid gas is disengaged, and a saline matter is obtained, which, when lixiviated, forms a solution of sulphate of cobalt. Nitric acid is decomposed by cobalt, and the metal is oxydized and dissolved. The solution is of a red colour, and by gentle evaporation affords minute prismatic crystals of the same colour, which are deliquescent and decomposed by heat. Muriatic acid does not act on cobalt, but with the assistance of heat; a small portion of the metal is then dissolved. The solution of muriate of cobalt affords a celebrated sympathetic ink. When much diluted, if letters are traced with it on paper, and allowed to dry, they are invisible; but when the paper is exposed to a moderate heat, they appear of a lively green: they disappear again when cold, and the experiment may be repeated for any number of times, taking care only to avoid too strong a heat, by which they are rendered permanent. The cause of this phenomenon has been ascribed to the muriate of cobalt fixed upon the paper attracting, when cold, moisture from the atmosphere, by which it is, as it were, dissolved and rendered invisible: when heated, this moisture is evaporated, and the green colour of the salt appears. This explanation appears to be confirmed by the fact, that the characters are rendered visible by confining the paper in a vessel with quick lime, or sulphuric acid, either of which attracts humidity powerfully. The green colour cannot, however, be ascribed entirely to the concentration, but is owing to the temperature; for the solution itself becomes green when moderately heated in a close phial, and loses this green colour as it cools; nor is it easy to explain how the temperature does produce this change of colour.

Cobalt combines with many of the metals. Its alloys are generally brittle, and none of them has been applied to any use; nor have they been much examined. The principal, or, indeed, almost the sole use of cobalt, is in communicating a blue colour to glass, enamel, and porcelain.

COBBING, in sea language, a punishment sometimes inflicted on a sailor: it is performed by striking him a certain number of blows on the breech with a flat piece of wood, called the cobbing-board.

COBITIS, the *loche*, in natural history, a genus of fishes of the order Abdominales. Generic character: eyes in the upper part of the head; mouth in the greater number of species bearded; body almost equally thick throughout, and covered with easily deciduous and small scales; tail rounded; air bladder hard or osseous. There are five species, of which we shall notice:—C. barbatula, or bearded loche. This is an inhabitant of the streams of Europe and Asia, and lives upon worms and insects, which it finds on the gravel at the bottom of the water, from which it rarely ascends near the surface. It is extremely prolific, and most highly valued for the table in several places in Europe, where it is cultivated with extreme attention. It dies almost immediately on being taken from the water. To preserve the exquisite flavour of it, it is considered by the dealers in this fish as of great importance frequently to shake the vessel of water in which it is placed. C. fossilis, or yellow-brown loche. This inhabits the stagnant and muddy waters of the midland parts of Europe, and in winter completely shelters itself in mud. It is restless before storms, quitting its retreat, and ranging about in various directions near the surface. When preserved in a vessel of water, with some earth at the bottom, it invariably indicates the approach of storms by peculiar agitation, and is on this account not unfrequently kept to answer the purpose of a barometer.

COCCINELLA, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ subclavated and truncated; feelers with semi-cordated tip; body hemispheric, with the abdomen flat beneath. This genus is easily distinguished by its hemispheric form, having the upper

parts convex, and the lower flat. The insects of this genus are known by the name of lady-birds. C. septempunctata, or seven-spotted lady-bird, is seen in every garden and field in the summer. It proceeds from a larva of a lengthened oval shape, with a sharpened tail, of a black colour, varied with red and white specks, and of a rough surface; it resides on various plants; and changes to a short, blackish, oval chrysalis, spotted with red, which gives birth to its beautiful inmate in the months of May and June. There are, according to Gmelin, nearly 200 species, distinguished, 1. into those whose shells are red or yellow, with black dots: 2. shells red, with yellow dots: 3. shells red or yellow, spotted with white: 4. shells yellow, spotted with red. They all feed, both in their larva and complete state, on the aphides or plant-lice, and are very serviceable in purifying vegetables of the myriads with which they are often infested.

COCCOCYPSELUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx four-parted, superior; corolla funnel-form; berry inflated, two-celled, many-seeded. There is but one species; *viz.* C. repens, a native of Jamaica.

COCCOLITE, in mineralogy, a species of the flint genus; of a green colour; occurs in large, coarse, and small granular distinct concretions; it is hard, scratches glass, and gives sparks with steel; specific gravity 3.3; it is infusible without addition; with carbonate of soda it melts into an olive-green, vesicular, slaggy glass; and, with borax, into a pale-yellow, semi-transparent glass; its constituent parts are,

Silica	42
Alumina	15
Calcareous earth	13
Oxide of iron	8
Manganese	14
Water	3
	95

COCCOLOBA, in botany, a genus of the Octandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx five-parted, coloured; corolla none; berry calycine, one-seeded; drupe. There are fourteen species.

COCCULUS *indicus*, the name of a poisonous berry, supposed to be used by brewers in their malt liquors, particularly in porter, to give it an intoxicating quality. But as the use of it is forbidden by the laws of the land, it would be unfair to impute the practice of it to any respectable house.

COCCUS, in natural history, a genus of insects of the order Hemiptera. Generic character: snout pectoral; abdomen bristled behind; wings two, upright in the males: females wingless. There are about fifty species; extremely fertile and troublesome in hot-houses and green-houses: the male is very active; the female has a body nearly globular, and is slow, inactive, and fixed to different parts of plants. The most important species is the coccus cacti, or cochineal coccus, celebrated for the beauty of the colour it yields when properly prepared. It is a native of South America, and feeds on the cactus opuntia. The female or officinal cochineal insect, in its full grown or torpid state, swells or grows to such a size, in proportion to that of its first or creeping state, that the legs, antennæ, and proboscis are so small, with respect to the rest of the animal, as hardly to be discovered except by a good eye, or with the assistance of a glass; so that on a general view it bears as great a resemblance to a seed or berry as to an animal.

When the female cochineal insect is arrived at its full size, it fixes to the surface of the leaf, and envelopes itself in a white cottony matter, which it is supposed to spin or draw through its proboscis, in a continued double filament, it being observed, that two filaments are frequently seen proceeding from the tip of the proboscis in the full-grown insect. The male is a small and rather slender dipterous fly, about the size of a flea, with jointed antennæ, and large white wings in proportion to the body, which is of a red colour, with two long filaments proceeding from the tail. It is an active, lively animal, and is dispersed in small numbers among the females, in the proportion of one male to 150 females. When the female has discharged all its eggs, it becomes a mere husk, and dies; so that great care is taken to kill the insects before that time, to prevent the young from escaping, and thus disappointing the proprietor of the beautiful colour. The insects when picked or brushed off the plants, are killed by the fumes of heated vinegar, or by smoke, and then dried, in which state they are imported into Europe. It is said, the Spanish government is annually more enriched by the profit of the cochineal trade, than by the produce of all its gold mines.

Cochineal is used in the large scale by dyers, and it is the fine colour so much esteemed in painting, known by the name of carmine: when properly mixed with hair-powder, it is what ladies use as rouge.

C. ilicis, or kermes, is a species adhering, in its advanced or pregnant state, to the shoots of the quercus coccifera, under the form of smooth reddish-brown grains or balls, of the size of small peas. The tree or shrub grows plentifully in many parts of France, Spain, Greece, and the islands of the Archipelago. The cocci are found adhering in groups of five, six, or more together, or pretty near each other. Woollen cloth dyed with kermes was called scarlet in grain; the animal having been popularly considered as a grain.

A very small species of this genus is often seen, in its torpid state, on the surface of different kinds of apples, particularly on the golden pippin. It is not more than the tenth of an inch in length, and is of a long oval shape gradually decreasing to a point at one end. It contains thirty or forty oval white eggs enveloped in a silky matter.

COCHLEA, in anatomy, the third part of the labyrinth of the ear. See Anatomy.

COCHLEARIA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ; or Cruciferæ, Jussieu. Essential character: silicle emarginate, turgid, scabrous; valves gibbous, obtuse. There are eight species.

COCKET is a seal belonging to the King's Custom-house, or rather a scroll of parchment sealed and delivered by the officers of the customs to merchants, as a warrant that their merchandises are customed. It is also used for the office where goods, transported, were first entered and paid their custom, and had a cocket or certificate of discharge.

COCKPIT, in a man of war, a place on the lower floor, or deck, abaft the main-capstan, lying between the platform and the steward's room, where are partitions for the purser, surgeon, and his mates.

COCKSWAIN, or Coxson, an officer on board a man of war, who has the care of the barge and all things belonging to it, and must be also ready with his crew to man the boat on all occasions: he sits at the stern of the boat, and steers.

COCOS, in botany, a genus of the Monoecia Hexandria class and order. Natural order of Palms. Essential character: male calyx three-parted; corolla three petalled; stamens six; female calyx five-parted; corolla three-petalled; stigmas three; drupe coriaceous. There are five species, of which C. nucifera, cocoa-nut-tree, is common almost every where within the tropics, and is cultivated in both Indies; it is found in a wild state in the Maldives and Ladrones, also in the islands of the South Seas. The roots are slender, simple, and flexible: they arise separately from the bottom of the trunk, and spread in all directions; some running to a great depth, while others creep almost parallel to the surface. The trees grow to a great height; their stems are composed of strong fibres, like net-work, which lie in several laminas over each other, out of which come the branches, or rather leaves, which grow 12 or 14 feet long. The flowers come out round the top of the trunk of the tree in large clusters: they are inclosed in a sheath, and the nuts afterwards are formed in large clusters, ten or twelve together. The fruit is properly a drupe; the skin is thin and very tough, the substance under this investing the shell is extremely fibrous; the shell is of a bony substance; the kernel adheres all round the inner wall of the shell, and the cavity is filled with a milky liquor. Besides the liquor in the fruit, there is a sort of wine drawn from the tree called toddy, and from which is obtained a spirit called arrack.

The coat of the tree is composed of strong fibres, which are made into sailcloth, cordage, &c. The trunk of the tree is used in all kinds of building; and the leaves are wrought into mats, baskets, and many other things for which osiers are employed in Europe: they serve also as coverings to their houses.

COD. See Gadus.

CODE, a collection of the laws and constitutions of the Roman Emperors, made by order of Justinian.

The code is comprised in twelve books; and makes the second part of the civil, or Roman law. There were several other codes before the time of Justinian, all of them collections or abridgements of the Roman laws. The most ancient code, or digest, was styled "Jus Papirianum," from the first compiler, Papirius, who flourished about the time of the Regifugium.

Code *military*, rules and regulations for the good order and discipline of an army. Of this description are the articles of war.

CODIA, in botany, a genus of the Octandria Digynia class and order. Essential character: calyx four-leaved; petals four;

common receptacle involucred. There is but one species, *viz*. C. montana, a shrub, found in New Caledonia.

CODICIL, a schedule, or supplement to a will, or other writing. It is used as an addition to a testament, when any thing is omitted which the testator would add, explain, alter, or retract; and is of the same nature as a testament, except that it is without an heir, or executor. So that a codicil is a less solemn will, of one that dies either testate or intestate, without the appointment of an heir; testate, when he that hath made his codicil, hath either before or afterwards made his testament, on which that codicil depends, or to which it refers: intestate, when one leaves behind him only a codicil without a testament, wherein he gives legacies only to be paid by the heir at law, and not by any heir instituted by will or testament. A codicil, as well as a will, may be either written, or nuncupative. Some authors call a testament a great will; and a codicil a little one. But there is this further difference between a codicil and a testament, that a codicil cannot contain the institution of an heir; and that in a codicil, a man is not obliged to observe strictly all the formalities prescribed by law for solemn testaments.

CODON, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx ten-parted, permanent; leaflets alternately shorter; corolla bell shaped, ten-cleft; nectary ten-celled, composed of ten scales; pericarpium two-celled, containing several seeds. There is but one species, *viz*. C. royeni.

CŒCUM, in anatomy, the first of the three large intestines, called intestina crassa.

COEFFICIENTS, in algebra, such numbers, or given quantities, as are put before letters, or unknown quantities, into which letters they are supposed to be multiplied: thus, in 3 a, or $b\,x$, or $c\,x\,x$; 3 is the coefficient of 3 a, b of $b\,x$, and c of $c\,x\,x$. When no number is prefixed, unit is supposed to be the coefficient; thus 1 is the coefficient of a or of b.

CŒLESTIAL *globe*. See GLOBE.

CŒLIAC *artery*, that artery which issues from the aorta, just below the diaphragm. See ANATOMY.

CŒLIAC *passion*, in medicine, a kind of flux, or diarrhœa, wherein the aliments, either wholly changed, or only in part, pass off by stool.

CŒLIAC *vein*, in anatomy, that running through the intestinum rectum, along with the cœliac artery.

CŒMETERY, or CEMETERY, a place set apart or consecrated for the burial of the dead. Anciently none were buried in churches or church-yards: it was even unlawful to inter in cities; instead of which they had cœmeteries without the walls. These were held in great veneration among the primitive christians.

COFFEA, in botany, in French *caffe*, so named from Caffa in Africa, where it grows abundantly; a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ Jussieu. Essential character: corolla salver-shaped; stamens upon the tube; berry inferior, two-seeded; seeds arilled. There are ten species of which C. arabica, Eastern coffee-tree, is seldom more than eighteen feet high in its native country, or more than twelve in Europe. The main stem grows upright, and is covered with a light brown bark; branches horizontal, opposite, brachiate at every joint; leaves opposite when fully grown, they are nearly five inches long, and an inch and half broad in the middle, ovate lanceolate. They generally continue three years. The flowers are produced in clusters at the base of the leaves, sitting close to the branches; they are of a pure white, with a very grateful odour, but of short duration, they are succeeded by berries which are well known, as well as the use of them. This species of coffee is greatly superior to the C. occidentalis, Western coffee-tree, which rarely exceeds six feet in height; the corolla is white and sweet scented; it is a native of Domingo, about Cape Francois, where it flowers in December. As the coffee-tree is an evergreen, it makes a beautiful appearance at every season in the stove, and particularly when in flower, and also when the berries are red, which is generally in the winter: as they continue along time in that state, there is scarcely any plant that deserves a place more than this.

COFFER, in fortification, a hollow lodgment athwart a dry moat, from six to seven feet deep, and from sixteen to eighteen broad, the upper part being made of pieces of timber, raised two feet above the level of that moat, which little elevation has hurdles, laden with earth, for its covering, and serves as a parapet with embrasures.

COFFERER *of the King's household*, a principal officer in the court, next under the Comptroller, who, in the compting-

house, and elsewhere at other times, has a special charge and oversight of other officers of the house, for their good demeanor and charge of their offices, to all which he pays their wages.

COFFIN, the case in which a dead body is intered; usually made of elm, or oak. It consists of a bottom, two ends, and two sides; the latter being sawed half through, at right angles with their length, so as to give a pliancy to the boards; whereby the shoulder bend is made to suit the corpse : the lid is afterward screwed down. Coffins are sometimes plain, but generally are covered with black serge, &c. and ornamented with white, or yellow escutcheons and handles. It is necessary, that, whatever cloth is used, not only in lining and covering the coffin, but in the shroud, &c. it should be of woollen: this is done for the benefit of our manufacturers. Persons of property are sometimes cased in lead, well soldered, and afterwards put into richly ornamented coffins, for the purpose of laying in state, or for being deposited in vaults. We have, among other ingenious inventions, patent coffins, which effectually preclude the depredations of that abominable crew, that obtain a livelihood by robbing cemeteries. The security of this contrivance arises chiefly from making the coffin so very strong, as to resist the instruments usually employed by what are termed, "Resurrection-men," and by making the lid to fit on with spring plugs, fitting into hitched sockets ; so that being once closed, they never can be severed, except by breaking the coffin to pieces. It is to be lamented that such practices are considered to be at all necessary under the plea of the bodies being subjects for dissection, and considerably aiding to anatomical and pathological research. Were all who suffer under the sentence of the law to be devoted to that purpose, many good effects might arise, and the obnoxious resource, now referred to, be discontinued. Our ancestors generally used stone coffins. The nations of Asia, Africa, and America, as well as the Turks in general, do not use any case for the interment of their dead. It is, however, to be remembered, that the shroud used by the Musselmans, both in Europe and throughout Asia, is called "Kauffin;" whence we may be led to conjecture that to have been the origin of our designation.

Coffins are by no means to be recommended; they cause a long continuance of that fermentation which is the parent of putrefaction, aiding the retention of infectious diseases for many months, and debarring the access of the surrounding soil, whereby the noxious particles would be absorbed and neutralized. Every coffin ought to be filled up with quick lime, whence the putrefaction would be accelerated, and the danger of infection be, at least, lessened. The Emperor of Germany, about 30 years back, prohibited coffins, and caused quick lime to be immediately used. Strange to say, such was the offence given to his superstitious and bigotted subjects, that this regulation, in itself wise, and intended for their safety, was the cause of very serious discontents, and to prevent insurrection, was shortly after repealed.

COGNIZANCE, in law, has divers significations: sometimes it is an acknowledgment of a fine, or confession of something done; sometimes the hearing of a matter judicially, as to take cognizance of a cause; and sometimes a particular jurisdiction, as cognizance of pleas is an authority to call a cause or plea out of another court, which no person can do but the King, except he can shew a charter for it. This cognizance is a privilege granted to a city or town, to hold plea of all contracts, &c. within the liberty; and if any one is impleaded for such matters in the courts at Westminster, the Mayor, &c. of such franchise may demand cognizance of the plea, and that it be determined before them.

In a military sense, it implies the investigation to which any person or action is liable. During the suspension of civil authority, every offence comes under military cognizance, is subject to military law, and may be proceeded upon according to the summary spirit of its regulation. The strongest instance of military cognizance is a drum-head court martial.

COHESION, one of the species of attraction denoting that force by which the parts of bodies stick together.

This power was first considered by Sir Isaac Newton as one of the properties essential to all matter, and the cause of all that variety observed in the texture of different terrestrial bodies. He did not, however, absolutely determine that the power of cohesion was an immaterial one, but that it might possibly arise, as well as that of gravitation, from the action of another. His doctrine of cohesion is thus expressed: "The particles of all hard homogeneous

bodies, which touch one another, cohere with a great force; to account for which, some philosophers have recourse to a kind of hooked atoms, which in effect is nothing else but to beg the thing in question. Others imagine that the particles of bodies are connected by rest, *i. e.* in effect by nothing at all; and others by conspiring motions, *i. e.* by a relative rest among themselves. For, myself, it rather appears to me that the particles of bodies cohere by an attractive force, whereby they tend mutually toward each other; which force, in the very point of contact, is very great; at little distances is less, and at farther distances is quite insensible."

But whatever the cause of cohesion may be, its effects are evident and certain. The different degrees of it constitute bodies of different forms and properties. Thus, Newton observes, the particles of fluids which do not cohere too strongly, and are small enough to render them susceptible of those agitations which keep liquors in a fluid state, are most easily separated and rarefied into vapour, and make what the chemists call volatile bodies; being rarefied with an easy heat, and again condensed with a moderate cold. Those that have grosser particles, and so are less susceptible of agitation, or cohere by a stronger attraction, are not separable without a greater degree of heat; and some of them not without decomposition.

Modern chemists have agreed to consider the attraction of cohesion as the instrument of aggregation, or the union of similar compounds, and are careful not to confound it with the elective attractions, though there may, in strictness, be no difference between them. See CHEMISTRY.

This kind of attraction is evinced by a variety of familiar experiments; as, by the union of two contiguous drops of mercury; by the mutual approach of two pieces of cork floating near each other in a bason of water; by the adhesion of two leaden balls whose surfaces are scraped and joined together with a gentle twist, which is so considerable, that if the surfaces are about a quarter of an inch in diameter, they will not be separated by a weight of 100*lb.*; by the ascent of oil or water between two glass planes, so as to form the hyperbolic curve, when they are made to touch on one side and kept separate at a small distance on the other; by the depression of mercury, and by the rise of water in capillary tubes, and on the sides of glass vessels; also in sugar, sponge, and all porous substances. And where this cohesive attraction ends, a power of repulsion begins.

It is uncertain in what proportion this force decreases as the distance increases: Desaguliers conjectures, from some phenomena, that it decreases as the biquadratic or 4th power of the distance, so that at twice the distance it acts 16 times more weakly, &c.

To determine the force of cohesion, in a variety of different substances, many experiments have been made, and particularly by professor Muschenbroek. The adhesion of polished planes, about two inches in diameter, heated in boiling water, and smeared with grease, required the following weights to separate them:

	Cold Grease.	Hot Grease.
	lb.	*lb.*
Planes of Glass	130	300
Brass	150	800
Copper	200	850
Marble	225	600
Silver	150	250
Iron	300	950

But when the brass planes were made to adhere by other sorts of matter, the results were as in the following table:

	oz.
With Water	12
Oil	18
Venice Turpentine	24
Tallow Candle	800
Rosin	850
Pitch	1400

In estimating the absolute cohesion of solid pieces of bodies, he applied weights to separate them according to their length: his pieces of wood were long square parallelopipedons, each side of which was .26 of an inch, and they were drawn asunder by the following weights:

	lb.
Fir	600
Elm	950
Alder	1000
Linden tree	1000
Oak	1150
Beech	1250
Ash	1250

He tried also wires of metal, 1-10th of a Rhinland inch in diameter: the metals and weights are as follow:

	lb.
Of Lead	29¼
Tin	40¼
Copper	299¼

	lb.
Of Yellow brass	360
Silver	370
Iron	450
Gold	500

He then tried the relative cohesion, or the force with which bodies resist an action applied to them in a direction perpendicular to their length. For this purpose he fixed pieces of wood by one end into a square hole in a metal plate, and hung weights towards the other end till they broke at the hole: the weights and distances from the hole are exhibited in the following table:

	Distance. inc.	Weight. oz.
Pine	$9\frac{1}{2}$	$36\frac{1}{2}$
Fir	9	40
Beech	7	$56\frac{1}{2}$
Elm	9	44
Oak	$8\frac{1}{2}$	48
Alder	$9\frac{1}{4}$	48

See his "Elem. Nat. Philos."

COIF, the badge of a serjeant at law, who is called serjeant of the coif, from the lawn-coif they wear under their caps when they are created serjeants.

COIL, in naval affairs, the manner in which all ropes are disposed aboard ships, for the conveniency of stowage. Coiling is a sort of serpentine winding the ropes, by which they occupy a small space, and are not liable to be entangled among one another in working the sails. The small ropes are frequently coiled by hand, and hung up to prevent them from being entangled among one another, in traversing, contracting, or extending sails.

COIN. Among the impediments to commerce, the greatest undoubtedly is the charge of conveyance from place to place. This is the great obstacle which limits the exchange of commodities from one extremity of the world to the other. Whenever the charges of carriage arise to such an amount as to equal the effectual return in any remote market, the motive for conveying merchandise to that place ceases. If goods were always exchanged for goods, it is clear that the conveyance, under the uncertainty of disposal, would take place to a very small distance indeed; and the labour required to discover the persons willing to exchange would greatly enhance the charge. It would require a volume to enumerate and describe the expedients, moral as well as mechanical, by which these difficulties are in part subdued, and still more to deduce their origin and general effects. One of the chief of these expedients consists in the use of some article of merchandise, as the medium of exchange which shall be acceptable to every man, and will therefore be received and held by the seller of any commodity until he shall meet with another individual, who he knows will again take it for the article he wants.

In the island of Madagascar, it is said, that the exchangeable value of goods is reckoned in hatchets, bullocks, and slaves; these commodities being universally vendible, and for that reason every where received. Smith affirms, that nails answer the same purpose in some parts of Great Britain. These, and other instances, may serve to shew how a preferable medium of exchange becomes adopted; and it will without difficulty be seen, that the scarcest and least destructible metals must have at length become the universal substitutes: for their value does not depend on their figure; they may be subdivided and joined again without loss; they receive no injury by keeping; and the labour of conveying them from place to place forms a less part of their value than of any other article.

The first monies were mere quantities of metals ascertained by weight, as the names of most species still indicate. The interference of governments was found necessary to assure the weight, and more particularly the fineness of determinate portions of metal; and this has given rise to an opinion, that a part of the value of coin must depend on the edict of the state which issues it. Whether statesmen themselves have in reality thought this to be the case is little to the purpose; but it is certain that they have from time to time yielded to the temptation of diminishing the quantity of precious metal issued under a given denomination, either by openly deducting from the weight, or secretly debasing the coin. Transactions of this kind must have operated to the loss of all the creditors in the state; but they have never deceived the sellers, who have always regulated their prices by their knowledge of the real quantities of the metal, and not by the denomination or the supposed weight or fineness it might denote. The imaginary coin, or money of account, to be found in the mercantile books of almost every commercial nation, must have arisen partly from this cause.

This diminution has taken place throughout Europe. With us the pound of money, which about the year 1087 contained a

pound weight of silver, has continued at less than one-third (or $\frac{20}{62}$) of that quantity ever since the reign of Elizabeth. Our neighbours, however, have universally exceeded us in this respect. Thus the pound Flemish is less than eleven shillings, the French livre is ten pence, and the Italian lire is less than $2\frac{1}{4}d$.

The Chinese still use fine silver, which they actually cut and weigh at every single payment. They are said to have formerly possessed silver coin; but whether they were urged to their present practice by the uncertain variation in its value caused by their rulers, or by the difficulty of otherwise resisting the artifices of coiners, we know not.

The metals used for coinage are gold, silver, and copper. According to the exchangeable value of gold, half a grain of this metal would purchase as much bread as a man could eat at one meal. This small piece of gold, if as thin as paper, would not measure the tenth part of an inch in breadth, and would therefore be perfectly inconvenient for use. It has, in fact, been found, that the gold coin of the weight of 32 grains (or the quarter guinea) was too small to be conveniently used. The same observations will apply to the smaller subdivisions of the shilling of silver; whence, upon the whole, it appears that coins of all the three metals are required to facilitate our commerce of buying and selling.

Gold, silver, and copper, like every other product of human industry, depend for their value principally on the labour employed in producing and bringing them to market, and in a considerable degree on the actual demand. As these articles are not employed merely in the fabrication of coins, the demand will vary in each according to circumstances, which admit of no permanent ratio of exchange between them. If the state were to coin certain pieces of known weight and fineness out of each of these metals, and determine that a certain number of the silver pieces, for example, should in all cases be equivalent to one piece of the gold, it would naturally follow, supposing the individual to pay nothing for the coinage, that a debt might be discharged with more facility to the debtor, and consequently loss to the creditor, in the cheapest of these two metals, whenever by the fluctuation of the market either of them should come to represent a larger portion of the other than the edict of the government had determined. This consequence of fixing the relative value of coins would shew itself in a variety of ways, which need not be enumerated; because it is certain that the dearer metal would occupy the greater part of the circulation while the cheaper pieces would either be melted down, or diminished if their rated value were too high, and they would be fabricated by individuals if it were too low, in defiance of every public regulation which might be adopted. If we therefore admit, from considerations of this nature, that no government does in reality possess the means of fixing a ratio between two articles of commerce, intended to be applied as the tickets of transfer, or the mediums of exchange, we shall be naturally led to the adoption of one of the metals only, as the representative sign, while the two others are applied merely as instruments of accommodation for the convenient subdivision of value.

With regard to the question of preference in these three metals, experience has shewn that society is disposed to assume the dearest; namely, gold. With a single standard of value, the fluctuations of the market price of the metal, when compared with commodities, will be nearly imperceptible, because they confound themselves with the rise and fall in the prices of all other articles to which the standard is thus applied. If a cheaper metal were to be adopted by the state, and gold were left to circulate at election of individuals, the changes of price in this metal of high value would operate so as to produce an uncertainty in the amount of large sums, and greatly disturb the general transactions of commerce. Merchants would therefore consider the gold coin as mere bullion, and the community would in a great measure be deprived of its use as a coin; as actually is the case in Holland and other countries where silver is the legal medium. A more defective scheme was proposed in France in a report presented by Prieur, from a committee of the Council of Five Hundred, of which a very full abstract is given in the Moniteurs of 6 and 7 Floreal, in the year vi. Nos. 216, 217. It is, that silver coin should be unchangeable in weight and denomination of value; but that the price of gold (also coined) should be settled every six months by a declaration from the national treasury, deduced from the medium price of that metal during the preceding half year. It was rejected

by the Council of Ancients. It appears most eligible, that gold in pieces of determinate weight and fineness should constitute the effective coin of the state, or legal tender of payment; that silver and copper should be formed into money for the purpose of representing fractions of the smallest gold coin; and that the creditor or seller should have the option to refuse all payments in these last metals of any sum exceeding the smallest unity of the gold coin.

By this distribution, though the coins of silver and copper would, in strictness, be subject to some fluctuations arising from the state of the market with regard to those metals, yet the difference would be disregarded in the discharge of accounts, because it would never amount to a sum of any importance. The only inconvenience which offers itself under such an arrangement is, that these subordinate coins would also be melted and sold when the metal was dear, and they would be fabricated if the metal ever happened to be so cheap as to afford an adequate motive of profit to the illegal coiner. The state, on its deliberations on this subject, might determine that the coins of silver and copper should pass either for more or for less than the medium market price of the metal, or for that value precisely. It is evident that the first of these dispositions would afford coin which would continually vanish into the melting-pot, and is therefore altogether unadvisable. The medium rate of intrinsic value would produce a similar effect whenever the market price was low. Whence it follows, that the metal contained in such auxiliary money ought to be of less value than the gold it represents; and to prevent the introduction of a similar coinage from private manufacturers, it would be necessary that the difference between the value of the metal and that represented by the coin should be somewhat less than the cost of workmanship. Under these circumstances the public would be supplied with an useful implement or ticket of exchange, which would operate as a pledge of value, very nearly to the amount of its denomination, and would be afforded cheaper from the extensive manufactories of government than it could possibly be made by private workmen.

Coin, like every other utensil or tool, is subject to wear, and will, in process of time, be more or less deprived of its distinctive figure, and rendered less valuable by the loss of weight. When new, it is the real pledge of measure it pretends to be; but, if it be suffered to circulate after its weight is considerably diminished, it may become a desirable object to the coiner to fabricate new pieces apparently in the worn state, or otherwise he may exercise his industry in speedily reducing the new coin to that state, for the sake of the precious metal he may thus acquire.

If, on the contrary, the legislature should forbid the currency of pieces worn beyond a certain small or moderate loss, the consequence will be, that all such pieces will return to the mint to be coined; and the charge of coinage may become so heavy as to absorb a considerable part of the value of the whole circulating medium in the course of a few years.

To diminish this last inconvenience as much as possible, it becomes necessary to attend to the nature of the metal, as well as the figure of the piece. Whether the Dutch ducat, of fine gold, or the English guinea, of 22 carats, may, under like circumstances, be most disposed to lose by wear, has not, we believe, been determined; but it seems to be generally understood, that our standard gold, in watch-cases and other trinkets, is less durable than the coarser and harder gold allowed to be wrought in France and Geneva. If this be true, it should seem, that there exists no motive for raising the standard of our gold; and perhaps the same argument may apply still more to our silver; and the advantage, if any, in lowering the standard without diminishing the intrinsic value, has not yet been shewn with sufficient evidence to justify the offence against established use and public prejudice, which such a proceeding might afford. Admitting the observations to be conclusive against altering the standard, it would follow, that the greater durability of coin must be sought for in its figure.

Let us imagine a coin to possess the figure of an equilateral triangle; let it be thin, in order that it may present a large surface; let its edges have the figure of a saw, and its faces that of a file. Under these conditions, we should fabricate one of the worst or least durable coins that could be chosen: for the angles would be easily broken and worn, and the edges and faces would mutually operate on each other, with a degree of rapidity which, it may be concluded, would very soon take away all the sharp prominences, and greatly dimi-

nish the weight: on the other hand, let us suppose the least possible surface, and we shall obtain the spherical figure. The pagoda and fanam of India are the only coins, which we recollect, that approach towards this figure. Against this, it appears an objection, that if it be nearly perfect, the impressions descriptive of its purity and denomination must be indented, and will not therefore sufficiently limit its apparent magnitude; and if they be prominent, it will no longer be a sphere, but a figure presenting sharp angular parts, with small bearings very liable to destruction. What then is the figure that shall partake so much of the plane, as to present surfaces of broad contact or bearing, and afford the quantity of angular prominence? It is evidently the cylinder: and this is the figure most generally adopted for money. The edge of the cylinder affords the smallest bearing; it therefore must be very short and flat, in order that the weight of the piece may be disposed to rest on the base, and not the edge.

If the whole surface of a piece of metal were covered with figures or impressions, it would immediately be seen whether any part had been abraded by accident or design. If the impressions were concave they might easily be renewed by the punch or the graver; but if they were in relief it would be almost impossible, when once worn or obliterated. For this reason the preference, in coinage, has mostly been given to figures in relief.

It is, however, a very serious inconvenience, that when the distinctive marks are thus rendered prominent, the face of the coin no longer sustains the pressure and wear of the piece; but the marks themselves are made to support the whole. Thus, in our gold money, particularly of the last coinage, the edge is a saw, and the numerous minute prominences of the face constitute a file; the operations of both which are felt in the rapid destruction of the piece.

To place this in a more striking light, it may be observed that the amount of gold coined between the years 1762 and 1772, both inclusive, was 8,157,233*l.* 15*s.* 6*d.*; and between 1782 and 1792, both inclusive, was 19,675,666*l.* 14*s.* 6*d.*; and between 1773 and 1777, both inclusive, was 19,591,833*l.* 1*s.* During the middle period, last mentioned, the great coinage of gold took place. We are aware that other causes may have occasioned a demand for coin, besides the mere wear of the old pieces, and that the increase of commerce and manufactures has in fact produced such a demand; but as this last event (distinguishable by its gradual progress) does not appear, from the numbers in the account, to have influenced the coinage in any great proportion; we shall disregard it in this present rough statement. With this liberty, we may proceed to remark, 1st. That as most of the old pieces disappeared during the middle term of time, the number of nineteen, or say twenty millions, must nearly represent the whole of our gold money. 2d. That the national loss by wear in the first period, when the gold was old and smooth, reckoned at one half per cent. on the sum recoined, was 3708*l.* per ann.; and in the latter period 8943*l.* per ann. And, 3d. That the whole national stock of gold coin, under the regulations and figure of the last period, wears out, it is reckoned, every eleven years. This account of the coinage is to be found in the "Report of the Lord's Committee of Secrecy," printed April 28, 1797.

Hence we may observe, that neither kind of mark alone is suited for a coin intended to possess durability, and at the same time to be difficult either to imitate or diminish. A combination of both methods is necessary. If a coin be struck with indentations or parts depressed beneath the common surface, and in these there be prominent objects or designs not more elevated than that surface; the general advantage, with regard to wear, will approach towards that of the plain surface itself; and the impression will be at least as difficult to imitate, if not more so than that of a design raised totally above the common surface. Few coins have been made of this figure. The Chinese coin, of mixed copper, called the cash, is the most remarkable, and perhaps the only one of extensive circulation. The late copper coinage of pieces of one and two pennies are of this kind.

To sum up the foregoing conclusions in a few words, we may remark that, 1. The state is unable (from the natural impracticability of things) to appoint two distinct articles of commerce as the circulating mediums of exchange. 2. The measure of value, or legal tender, ought to consist in the metal which bears the highest price, namely, gold. 3. Coins of silver and copper are required for smaller fractions than the actual subdivisions of the gold coin, but

should be optional in the receipt of any larger sums. 4. These last mentioned coins ought to represent a value in gold equal to their own quantity of metal, at the highest (or perhaps medium) market price added to the charge of fabrication. 5. No sufficient reason has yet been given to shew that the standard of gold coin should be changed to render it more durable. 6. The best figure of coin is a short cylinder, or flat round plate. And, 7. The distinctive marks or impressions should be made neither altogether hollow, or altogether in relief, but by combination of both forms, so as to leave a flat bearing face on each side.

Sir Isaac Newton's TABLE of the Value of foreign Coins.

SILVER.	Assay.	Weight.		Value.
	dwts.	*dw.*	*gr.*	*d.*
The piastre, or piece of 8 reaus, now 10 reaus	*w.* 1	17	12	54.
New Seville piece of eight	$1\frac{1}{2}$	14		43.11
Mexico piece of eight	1	17	$10\frac{5}{9}$	53.83
Pillar piece of eight	*Stan.*	17	9	53.87
Peru piece of eight of uncertain alloy				
Old ecu of France of 60 sols, Turnois	*w.* 1	17	12	54.
New ecu of France 100 sols, 2 *dwt. w.* by law	$1\frac{1}{2}$	19	$14\frac{1}{2}$	60.39
Crusado of Portugal of 400 reas, now 480 reas	2	11	4	34.31
Patacks, or patagons of 500 reas, now 600 reas				
Ducaton of Flanders of 60 sols, or patars	*b.* $4\frac{1}{2}$	20	22	66.15
Patagon, or cross dollar of 48 patars	*w.* 12	18	1	52.91
Ducaton of Holland of 63 styvers	*b.* 3	20	21	65.59
Patagon, leg dollar, or rix dollar of 50 styvers	*w.* 14	18		52.28
The three guilder piece of 60 styvers	2	20	8	62.46
Guilder florin of 20 styvers	2	6	$18\frac{1}{2}$	20.08
The ten skelling piece of Zealand of 60 styvers	2	20	6	62.21
Lyon dollar of Holland of 42 styvers	44	17	14	43.07
Ducatoon of Collogn	*b.* 3	20	18	65.02
Rixdollar, or patagon of Cologn	*w.* 13	18	0	52.53
Rixdollar, or patagon of Bishop of Liege	12	17	$22\frac{1}{2}$	55.48
Rixdollar of Mentz	$6\frac{1}{2}$	18	8	55.27
Rixdollar of Frankfort	9	18	8	54.53
Rixdollar of the Elect. Palatine, before 1620		18	5	
Rixdollar of Nuremburg	6	18	10	55.55
Rixdollar of Lunemburg	10	18	11	54.65
Rixdollar of Hanover	8	18	12	55.03
Double gulden of the Elect. Hanover	7	18	18	56.29
Double gulden, or piece of two-thirds	*b.* $17\frac{1}{2}$	8	10	28.14
Half gulden, or piece of one-third	$17\frac{1}{2}$	4	5	14.07
Gulden of Zell, or piece of 16 gutz grosh	*w.* 43	11	2	27.07
Gulden of Hildesheim of 24 manen grosh, now 26	$40\frac{1}{2}$	11	22	30.21
Rixdollar of Madgburgh	10	18	12	54.27
Gulden, or guelder	44	11	14	28.67
Old rixdollar of the Elect. Brandenburgh	9	18	13	55.17
Old gulden of 24 manen grosh, now 26	43	12	4	30.41
Gulden, or piece of two-thirds	43	11	3	27.81
Half gulden, or piece of one-third	43	5	13	13.09
Gulden of the Elect. Saxony of two-thirds	41	11	3	28.12
Old bank dollar of Hamburgh	8	18	9	54.92
Old rixdollar of Lubec	$8\frac{1}{2}$	18	16	55.54
The 4 mark piece of Denmark	21	11	$13\frac{1}{2}$	32.45
The 8 mark piece of Sweden	*Stan.*	20	0	62.00
The 4 mark piece of Sweden	*w.* 58	13	12	30.92
The 2 mark piece of Sweden		6	19	
Old dollar of Dantzic	$10\frac{1}{2}$	18	9	54.27
Old rixdollar of Thorn, near Dantzic	12	18	$8\frac{1}{2}$	53.85
Rixdollars of Sigismund III. and Uladislaus IV. kings of Poland	10	18	9	54.04

SILVER.	Assay.	Weight.	Value.
	dwts.	dw. gr.	d.
Rixdollar of the late Emperor Leopold	$10\frac{1}{2}$	18 9	54.27
Rixdollar of the late Emperor Ferdinand III	$10\frac{1}{2}$	18 9	54.27
Rixdollar of Ferdinand, Archduke of Austria	$10\frac{1}{2}$	18 5	53.78
Rixdollar of Basil	$7\frac{1}{2}$	18 $18\frac{1}{2}$	56.24
Rixdollar of Zune	13	18 1	52.65
Old ducat of Venice, stamped "Ducatus Venetus"	$23\frac{1}{2}$	14 15	40.50
The half ducat	$23\frac{1}{2}$	7 $7\frac{1}{2}$	20.25
The new ducat, stamped 124, of *6l. 4s.* de picoli		18 2	
The half thereof		9 1	
The crusado croisat, or St. Mark, stamped 140, of 7 livres, de Picoli		20 6	
The half and quarter crusado, in proportion			
Another coin of Venice	*w.* 46	17 10	42.08
The piece of 2 jules	*b.* 6	3 15	11.05
Ducat de Banes of Naples of 100 grains	*w.* 3	14 $0\frac{1}{4}$	40.43
The half ducat	3	7 $0\frac{1}{8}$	20.21
The tarin, or fifth part of a ducat	3	2 $19\frac{1}{4}$	8.09
The carlin, or tenth part	3	1 $9\frac{1}{2}$	4.04
Escude ecu, or crown of Rome, of 10 julios		20 $14\frac{1}{2}$	
Teston of 3 julios	1	5 $21\frac{1}{2}$	18.32
Ducat of Florence and Leghorn of $10\frac{1}{2}$ julios	*b.* 8	20 3	64.62
Julios of Rome		2 5	
Piastre ecu, or crown of Ferdinand II. Duke of Tuscany	*w.* 1	17 12	54.
Piastre ecu, or crown of Cosmus III	1	16 18	51.69
Croisat of Genoa of $7\frac{1}{2}$ lires	*b.* 7	24 15	78.74
Ecu d'argent of 7 lires, 12 sols			
Piastre ecu, or crown of Milan		17 21	
Philip of Milan of 7 lires		20 20	
Livre of Savoy of 20 sols		3 22	
The 10 sols piece		1 23	
A roupee	$16\frac{1}{2}$	7 10	24.07
Goud gulden, or florin d'or of 28 styvers	75	12 19	26.26
Another	48	11 0	26.72
Another	48	12 0	29.15

TABLE OF GOLD COINS UNWORN.	Assay.	Weight.	Value.
	ca. gr.	dw. gr.	s. d.
Old Lewis d'or, the half and quarter in proportion	*w.* 0 $0\frac{1}{2}$	4 8	16 9.3
New Lewis d'or, the half and quarter in proportion	0 $1\frac{1}{2}$	5 $5\frac{2}{5}$	20 0.6
Old Spanish double doubloon	0 $0\frac{1}{2}$	17 8	67 1.4
New Spanish double pistole, half in proportion	0 $0\frac{1}{2}$	8 16	33 6.7
New Seville double pistole, half and quarter in proportion		8 $16\frac{1}{3}$	
The double moeda of Portugal, new coined	0 $0\frac{1}{4}$	6 22	26 10.4
Ditto, as they come to England	0 $0\frac{1}{4}$	6 $21\frac{3}{4}$	26 9.9
The moeda	0 $0\frac{1}{4}$	3 11	13 5.1
Half moeda	0 $0\frac{1}{4}$	1 $17\frac{1}{2}$	6 8.5
Hungary ducat	*b.* 1 2	2 $5\frac{2}{3}$	9 3.6
Ducats of Holland and of Bishop of Bamburgh	1 2	2 $5\frac{1}{2}$	9 3.2
Double ducat of the Duke of Hanover	1 2	4 $10\frac{1}{2}$	18 4.8
Ducat of the Duke of Hanover	1 2	2 $5\frac{1}{4}$	9 2.7
Ducats of Brandenburgh, Sweden, and Denmark	1 2	2 $5\frac{1}{2}$	9 3.2
Ducat of Poland	1 2	2 5	9 2.1
Ducat of Transylvania	1 $1\frac{1}{2}$	2 $4\frac{3}{4}$	8 11.6
Sequin, Chequin, or Zeachein, of Venice	1 $3\frac{1}{7}$	2 $5\frac{3}{4}$	9 5.7
Old Italian pistole	*w.* 0 $0\frac{1}{4}$	4 $6\frac{3}{4}$	16 7.6
Double pistole of Pope Urban, 1634		8 $14\frac{1}{2}$	
Half pistole of Innocent II. 1685		2 4	
Double pistole of Placentia		8 10	
Double pistole of Genoa, 1621		8 16	
Double pistole of Milan		8 $13\frac{1}{2}$	

TABLE OF GOLD COINS UNWORN.	Assay.	Weight.	Value.
	ca. gr.	dw. gr.	s. d.
Single pistole of Milan		4 $6\frac{3}{4}$	
Single pistole of Savoy		4 $8\frac{1}{2}$	
Double ducat of Castile, Genoa, Portugal, Florence, Hungary, and Venice	b. 1 $2\frac{1}{2}$	4 11	18 17.7
Single ducats of the same places	1 $2\frac{1}{2}$	2 $5\frac{1}{2}$	9 3.8
Double ducats of several forms, in Germany	1 1	4 11	18 4.
Single ditto	1 1	2 $5\frac{1}{2}$	9 2.
Double ducat of Genoa	1 2	4 11	18 6.5
Single ducat of Genoa, Besançon, and Zurich	1 2	2 $5\frac{1}{2}$	9 3.2
Pistoles of Rome, Milan, Venice, Florence, Savoy, Genoa, Orange, Trevon, Besançon	w. 0 $0\frac{1}{4}$	4 6	16 6.7
Ducat of Barbary, with Arabic letters	2 $1\frac{1}{2}$	2 $16\frac{1}{4}$	9 3.5

COIN, *laws relating to.* Counterfeiting the king's money, or bringing false money into the realm counterfeit to the money of England, clipping, washing, rounding, filing, impairing, diminishing, falsifying, scaling, lightening, edging, colouring, gilding, making, mending, or having in one's possession, any puncheon, counter puncheon, matrix, stamp, dye, pattern, mould, edger, or cutting engine: all these incur the penalty of high treason. And if any person shall counterfeit any such kind of gold or silver, as are not the proper coin of the realm, but current therein by the king's consent, he shall be guilty of high treason.

If any person shall tender in payment any counterfeit coin, he shall for the first offence, be imprisoned six months; for the second offence two years; and for the third offence shall be guilty of felony without benefit of clergy.

Blanching copper or other base metal, or buying or selling the same; and receiving or paying money at a lower rate than its denomination doth import; and also the offence of counterfeiting copper halfpence and farthings; incur the penalty of felony, but within clergy. Counterfeiting coin not the proper coin of this realm not permitted to be current therein, is misprision of treason. A person buying or selling, or having in his possession, clippings or filings, shall forfeit 500*l.* and be branded in the cheek with the letter R. And any person having in his possession a coining-press, or casting bars or ingots of silver in imitation of Spanish bars or ingots, shall forfeit 500*l.*

A reward of 40*l.* is given for convicting a counterfeiter of the gold or silver coin; and 10*l.* for a counterfeiter of the copper coin.

COINING, the art of making money, which has hitherto been performed by the hammer or the mill. The first operations are the mixing and melting of the metal, because there is no species of coin of pure gold or silver, but requires a quantity of alloy. See ALLOY. For gold coin the alloy is a mixture of silver and copper, as silver alone would make the coin too pale, and the copper alone would give it too high a colour. The alloy is used for the purpose of rendering the coins harder, and less liable to wear, or to be diminished by art. When the gold and silver are completely melted and mixed, they are cast into long, flat bars, nearly of the thickness of the coin to be cast. In coining by the mill, which has been the only method in use for the last 250 years, the bars are taken out of the moulds, and scraped, brushed, flattened in a mill, and brought to the proper thickness of the species to be coined. The plates thus reduced as nearly as possible to the proper thickness, are cut into round pieces, called blanks, or planchets, with an instrument fastened to the lower end of an arbor, whose upper end is formed into a screw, which being turned by an iron handle, turns the arbour, and lets the steel, well sharpened in form of a punch-cutter, fall on the plates; and thus a piece is punched out. The pieces are now to be brought to the standard weight by filing or rasping, and what remains of the plate between the circles is melted again. The pieces are next weighed in an accurate balance, and those that prove too light are re-melted; but those that are too heavy are filed to the standard weight. When the blanks are adjusted, they are carried to the blanching-house, where the blanks are brought to their proper colour. They are next milled, by means of a machine which consists of two plates of steel in form of rulers, on which the edging is engraved, half on the one and half on the

other. Being thus edged, the impression is given them by the mill, which is so contrived that the metal receives at once an impression on each side, and becomes money as soon as it has been examined and weighed. The process for coining medals is nearly the same with that of money: there is, however, this difference, that money from the smallness of the relievo receives its impression at once, whereas medals require several strokes. The figures of the coining-mill have been so frequently given, that it seemed to us needless to insert them here, especially as a new method of coining has been introduced by Messrs. Bolton and Watt, which is shortly to be the only mode used in this country. For this purpose buildings are erecting on Tower-Hill. This machinery invented by these able mechanicians has been long used in the manufacture of copper money; it works the screw-presses for cutting out the circular pieces of copper, and coins both the edges and faces of the money at the same time, with such superior excellence and cheapness of workmanship as will prevent clandestine imitation. By this machinery, four boys are capable of striking 30,000 pieces of money in an hour; and the machine acts at the same time as a register, and keeps an unerring account of the number of pieces struck.

Coining, in the tin-works, is the weighing and stamping the blocks of tin with a lion rampant, performed by the king's officer; the duty for every hundred weight being four shillings.

COIX, in botany, a genus of the Monoecia Triandria class and order. Natural order of grasses. Essential character: males in remote spikes; calyx glume two-flowered awnless; corolla glume awnless; female, calyx glume two-flowered; corolla glume awnless; style two parted; seeds covered by the calyx ossified. There are three species.

COKE, a preparation of fossil coal, whereby it is deprived of the naptha, bitumen, or asphaltum it may contain, so that when applied to certain purposes, it may not communicate a bad flavor or bad qualities. Coke is made in very large ovens, principally from the refuse or brush-coal, with which some pits abound; the coal in them being extremely brittle, and rarely coming away in large pieces. The ovens have vents and mouths that are occasionally stopped, in part, for the purpose of regulating the heat, which, in no case should be such as to consume, but merely to char. The ovens being closed, at a proper time, the fire is gradually extinguished, and the coke is compacted into large masses, requiring to be broken before they can be taken out. In this state it will burn with a clear and steady heat, free from fumes, and consequently without occasioning malt (which is usually dried with coke, where coal pits are at hand) to partake of a bitumenous or smoky flavor. Good coke should be light, rather little, and more close than cellular; that which is of a deep ash colour is in general preferable: when black, or at all glossy, it is a certain sign of the want of due preparation; it ought to be equally charred, and in large lumps, from the size of a quartern loaf to a bushel: the small refuse is not profitable, and often is too much burnt.

COLCHICUM, in botany, *meadow saffron*, a genus of the Hexandria Trigynia class and order. Natural order of Spathaceæ. Junci, Jussieu. Essential character: spathe; corolla six-parted, with a rooted tube; capsule three, connected, inflated. There are three species.

COLD. When we leave a room at the temperature of 60°, and go into the air in a frosty day at the temperature of 30°, we say it is cold; or when the hand is held in water at the temperature of 100° for a few minutes, and then suddenly plunged into water at the temperature of 40°, the latter is said to be cold. This, however, is merely an expression of the sensation excited in the body, which depends solely on the abstraction of its heat. This may be proved by the following experiment. If three quantities of water are taken, the first at the temperature of 30°, the second at the temperature of 50°, and the third at the temperature of 98°. Immerse the right hand into the water at the temperature of 98°, and the left into the water at the temperature of 30°. Let them both remain for a minute, and then suddenly plunge both hands into the water at the intermediate temperature of 50°, to the right hand it will feel cold, and to the left warm: thus different sensations are produced by the same body at the same time, and at the same temperature. But this depends entirely on the previous state of the hands, and on the absorption or abstraction of the caloric. The right, which was placed in the water at the temperature of 98° absorbed caloric, because the temperature of the water is above that of the body. This

excites the sensation of heat: but when the same hand is placed in the water at the temperature of 50°, it is deprived of caloric, because the surrounding medium is far below its temperature, and thus the sensation of cold is produced. But from the left, placed in the water at 30°, caloric is abstracted, which gives the sensation of cold, and the same hand placed in the water at 50°, receives caloric, and this entering the body, excites the sensation of heat. Thus the term cold is expressive of the relative temperature of two bodies. There have, however, been persons who would account for the phenomena of cold by the existence of frigorific particles, supposed to be floating in the air, and by mixing with liquid bodies convert them to solids, and there are facts which seem to support this doctrine.

Nothing appears at first sight more directly contradictory to the common opinion of cold being only relative, and only a negative term implying the abstraction of heat, than the facts which shew the apparent radiation, absorption, and reflexion of cold; the evidence of which stands on the same ground as the corresponding motions of heat, namely, on the rise or fall of the thermometer. If the rise of the liquor on the scale of a thermometer, whose bulb is placed in the focus of a mirror, be considered as a proof of the propulsion of certain calorific rays from a distant heated surface, and their subsequent reflexion according to the laws of catoptrics; the sinking of the same thermometer liquor under similar circumstances of position, when the surface which before was sensibly hotter than the atmosphere is now sensibly colder, would seem from a parity of reasoning to indicate the propulsion and reflexion of frigorific rays. Nor can we consider this question as at all determined, though an ingenious hypothesis has been advanced by M. Prevost, which goes a considerable way to reconcile the apparent contradiction of the doctrine of the unity of heat and cold.

It is singular that the reflexion of cold should have been accidentally discovered, and decidedly announced about the year 1667, by the members of the Florentine Academy del Cimento, without any further prosecution of so curious a fact. The experiment is the following: a mass of ice of about 500*lb.* was set some distance before a concave glass mirror, and the bulb of a spirit thermometer put in the focus to try whether cold would be reflected. Immediately the spirit of the thermometer began to sink, and fell several degrees. To prove that this was not merely owing to the contiguity of the ice, the surface of the mirror was covered with a cloth to prevent the reflexion, and the thermometer again rose. No further inference is drawn from this experiment, and the author of it seemed even to doubt of the reality of the reflexion, and to be disposed to impute it to some other unknown cause. This experiment was repeated in a much more accurate way by M. Pictet. The apparatus which he used was the same as that before described, as employed for the reflection of heat; that is, two tin mirrors placed directly opposite each other at some distance, in the focus of one of which was placed the bulb of a very sensible thermometer, and in the other, the vessel intended to produce the heat or cold. In this instance, this latter was a mattress full of snow: the mirrors were separated to the distance of $10\frac{1}{2}$ feet. At the instant the mattress was placed in one focus, the thermometer in the opposite focus began to sink, and descended several degrees. When stationary, nitrous acid was poured on the snow, which produced a cold of much greater intensity, and the thermometer in consequence immediately descended several degrees lower. When taken out of the focus, it again rose to the common temperature.

Mr. Leslie also found, not only the same effect in this experiment, but that the action of a cold-radiating surface upon the tin reflector produced exactly the same proportional effect upon the differential thermometer as the hot radiating surface, only in the opposite direction of the scale. The differential thermometer, which is always at zero when both bulbs are equally heated, is beautifully calculated to shew this striking experiment. Thus, if the difference of temperature between the heat-radiating substance and the atmosphere be 60 degrees, and if this raises the thermometer 45 degrees, the same difference between the cold-radiating substance and the atmosphere will sink the thermometer 45 degrees, and so in proportion; so that a cold of 16 degrees will sink the thermometer 12 degrees; for 60 : 45 :: 16 : 12.

Great degrees of cold are produced by mixing together those substances which dissolve rapidly. The reason of this will appear by recollecting what has been said of the absorption of caloric when a solid body is converted into a fluid. Mixtures

to produce artificial cold, are generally made of the neutral salts dissolved in water; of diluted acids and some of the neutral salts; and of snow or pounded ice with some of these salts. A great number of experiments were made upon this subject by Mr. Walker; also by Professor Lowitz of Petersburgh; by Fourcroy and Vauquelin; and by Guyton. The following table exhibits the results of some of these experiments.

Table of freezing mixtures.

Mixtures.	Parts.	*Thermom. sinks.*
1. Muriate of ammonia	5	from 50° to 10°.
Nitre	5	
Water	16	
2. Muriate of ammonia	5	from 50° to 3°.
Nitre	5	
Sulphate of soda	8	
Water	16	
3. Sulphate of soda	5	from 50° to 0°.
Diluted sulphuric acid	4	
4. Snow	1	from 52° to 0°.
Common salt	1	
5. Snow or pounded ice	2	from 0° to —5°.
Common salt	1	
6. Potash	4	from 32° to —51°.
Snow	3	
7. Muriate of lime	3	from 32° to —50°.
Snow	2	
8. Muriate of lime	2	from 0° to —66°.
Snow	1	
9. Muriate of lime	3	from —40° to —73°.
Snow	1	
10. Diluted sulphuric acid	10	from —68° to —91°.
Snow	8	

When any of these substances are to be employed as freezing mixtures, the salts should be used fresh crystallized, and reduced to fine powder: and it will perhaps be found most convenient to observe the proportions which are set down in the table. Suppose it is wanted to produce a degree of artificial cold equal to —50°, which is the temperature produced from 32° by the seventh freezing mixture. The substances employed, namely, the muriate of lime and the snow, must be previously cooled down to the temperature of 32°, or any degree below it. This may be done by placing them separately in the third freezing mixture, the sulphate of soda, and diluted sulphuric acid, which reduces the temperature from 50° to 3°; or in the fourth freezing mixture of snow and common salt, which reduces the temperature from 32° to 0°. The materials thus cooled down, are then to be mixed together as quickly as possible, when, if the experiment succeed, the temperature will fall from 32° to —50°, as in the seventh freezing mixture. The vessels which are employed for these processes should be very thin, and made of the best conductors of heat. Vessels of tin plate answer the purpose, and when acids are to be used, they may be lined with wax, which will secure them sufficiently against their action. They should be of no larger dimensions than just to contain the materials.

COLDENIA, in botany, so called in honour of C. Colden, a curious botanist of North America; a genus of the Tetrandria Tetragynia class and order. Natural order; Asperlfoliæ. Borragineæ, Jussieu. Essential character: calyx four-leaved; corolla funnel formed; styles four; seeds two, two-celled. There is but a single species, *viz.* C. procumbens, an annual plant, whose branches trail on the ground, they extend nearly a foot from the root, and divide into many smaller branches. It is a native of the East Indies, but has been cultivated here for half a century.

COLEOPTERA, in natural history, an order of insects, which includes all those whose wings are guarded by a pair of strong, horny, exterior cases or coverings, under which the wings are folded up when at rest. In common language these insects are called beetles, though, in reality, that term is now restricted to the Scarabæus genus. The wing-sheaths, or horny coverings, are sometimes called coleoptera, but more generally elytra. This is a very extensive order, divided into four classes.

A. antennæ clavate, thicker towards the tip: in this class there are three subdivisions; *viz.*

a. Club lamellate; three genera.

Lucanus Scarabæus Synodendron.

b. Club perfoliate; seven genera.

Byrrhus Dermestes Hydrophilus
Melyris Silpha Tetratoma
Tritoma.

c. Club solid or inflated; seven genera.

Anthrenus Bostrichus Coccinella
Curculio Hister Nitidula
Pausus.

B. antennæ moniliform; of which there are twelve genera; *viz.*

Attelabus	Brentus	Cassida
Chrysomela	Erodius	Horia
Meloe	Mordella	Opatrum
Staphylinus	Tenebrio	Zygia.

C. antennæ filiform; of these there are nineteen genera.

Alurnus	Apalus	Bruchus
Buprestis	Calopus	Cantharus
Carabus	Cryptocephalus	Cucujus
Elater	Gyrinus	Hispa
Lampyris	Lytta	Manticora
Necydalus	Notoxus	Pimelia
Ptinus.		

D. antennæ setaceous; of which there are eight genera.

Cerambyx	Cucindela	Dytiscus
Forficula	Leptura	Rhinomacer
Serropalpus	Zonitis.	

COLE-SEED. See Brassica.

COLE-WORT, in gardening, a species of brassica. See Brassica.

COLIC, in medicine, a severe pain in the lower venter, so called, because the disorder was formerly supposed to be seated in the colon.

COLISEUM, or Colisæum, in ancient architecture, an oval amphitheatre at Rome, built by Vespasian, wherein were statues set up, representing all the provinces of the empire: in the middle of which stood that of Rome, holding a golden apple in her hand.

COLIUS, the *coly*, in natural history, a genus of birds of the order Passeres. Generic character: bill convex above, straight under, short and thick; the upper mandible curved downwards; nostrils small, placed at the base and nearly hidden by the feathers; tongue jagged at the tip; tail long and wedged; toes divided throughout. There are four species, three of which are found in Africa, and the fourth in the Philippine islands. But little is known of their manners and habits.

COLLAR, in Roman antiquity, a sort of chain put generally round the neck of slaves that had ran away, after they were taken, with an inscription round it, intimating their being deserters, and requiring their being restored to their proper owners, &c.

Collar, in a more modern sense, an ornament consisting of a chain of gold, enamelled, frequently set with cyphers or other devices, with the badge of the order hanging at the bottom, wore by the knights of several military orders over their shoulders, on the mantle, and its figure drawn round their armories.

Thus, the collar of the order of the garter, consists of S S, with roses enamelled red, with a garter enamelled blue, and the George at the bottom.

COLLATERAL, in genealogy, those relations which proceed from the same stock, but not in the same line of ascendants or descendants, but being, as it were, aside of each other. Thus uncles, aunts, nephews, nieces, and cousins, are collaterals, or in the same collateral line: those in a higher degree, and nearer the common root, represent a kind of paternity with regard to those more remote.

Collateral, in a legal sense, is taken for any thing that hangeth by the side of another, whereto it relates; as a collateral assurance is that instrument which is made over and above the deed itself, for the performance of covenants, between man and man; thus called as being external, and without the nature and essence of the covenant.

COLLATION, in the common law, the giving or bestowing of a benefice on a clergyman by a bishop, who has it in his own gift, or patronage. This differs from presentation, in that the latter is properly the act of a patron, offering the clerk to the bishop, to be instituted into a benefice, whereas the former is the act of the bishop himself. The collator can never confer a benefice on himself. Anciently, the right of presentation to all churches was in the bishop; and now, if the patron neglects to present to the church, his right returns to the bishop by collation. If the bishop neglects to exercise his right of collation in six months, the archbishop may confer. If he neglect it for other six months, it falls to the crown.

COLLECTOR, in electricity, is a small appendage to the prime conductor of the electrical machine, generally consisting of pointed wires, affixed to that end of the prime conductor which stands contiguous to the glass globe, or cylinder, or other electric of the machine. Its office is to receive the electricity, whether positive or negative, from the excited electric, much more readily than the blunt end of the prime conductor would be able to receive it without that appendage.

COLLEGE, a particular corporation,

company, or society of men, having certain privileges founded by the King's licence.

Colleges in the Universities are generally lay corporations, although the members of the college may be all ecclesiastical. And in the government thereof, the King's courts cannot interfere, where a visitor is specially appointed.

The two Universities, in exclusion of the King's courts, enjoy the sole jurisdiction over all civil actions and suits, except where the right of freehold is concerned; and also in criminal offences or misdemeanours under the degree of treason, felony, or maim. Their proceedings are in a summary way, according to the practice of the civil law. But they have no jurisdiction unless the plaintiff or defendant be a scholar or servant of the university, and resident in it at the time. An appeal lies from the Chancellor's court to the congregation, thence to the convocation, from thence to the delegates.

College *of Civilians*, commonly called Doctors' Commons, founded by Dr. Harvey, Dean of the Arches, for the professors of the civil law residing in the city of London. The judges of the arches, admiralty, and prerogative court, with several other eminent civilians, commonly reside here. To this College belong thirty-four proctors, who make themselves parties for their clients, manage their causes, give licenses for marriages, &c. In the Common Hall of Doctors' Commons are held several courts, under the jurisdiction of the civil law, particularly the High Court of Admiralty, the Court of Delegates, the Arches Court of Canterbury, and the Prerogative Court of Canterbury, whose terms for sitting are much like those at Westminster, every one of them holding several court days; most of them fixed and known by preceding holy days, and the rest appointed at the judge's pleasure.

College *of Physicians*, a corporation of physicians in London, whose number, by charter, is not to exceed eighty. The chief of them are called fellows, and the next candidates, who fill up the places of fellows as they become vacant by death, or otherwise. Next to these are the honorary fellows, and lastly, the licentiates, that is, such as being found capable upon examination, are allowed to practise physic.

This College has several great privileges granted by charter and acts of parliament. No man can practise physic in, or within seven miles of London, without license of the College, under the penaltry of 5*l*. Also, persons practising physic in other parts of England are to have letters testimonial from the president and three elects, unless they be graduate physicians of Oxford or Cambridge. Every member of the College is authorized to practise surgery in London, or elsewhere; and that they may be able at all times to attend their patients, they are freed from all parish offices.

The College is governed by a president, four censors, and twelve electors. The censors have, by charter, power to survey, govern, and arrest all physicians, or others, practising physic in or within seven miles of London; to fine, amerce, and imprison them at discretion; to search apothecaries' shops, &c. in and about London; to see if their drugs, &c. be wholesome, and the compositions according to the form prescribed by the College in their dispensaries; and to burn, or otherwise destroy, those that are defective or decayed, and not fit for use. They are judges of record, and not liable to action for what they do in their practice but by judicial powers; subject nevertheless to appeal to the College of Physicians. By law, if any person, not expressly allowed to practise, take upon him the cure of any disease, and the patient die under his hand, it is deemed felony in the practiser.

College *Royal of Physicians*, is also a corporation of physicians in Edinburgh, erected by King Charles II. granting them, by patent under the great seal, an ample jurisdiction within this city and liberties, commanding the courts of justice to assist them in the execution of their orders. These have the sole faculty of professing physic here, and hold conferences once a month for the improvement of medicine. This College consists of a president, two censors, a secretary, and the ordinary society of fellows, who, upon St. Andrew's day, if it falls on a Thursday, if not, on the first Thursday after, elect seven counsellors, who chuse the president and the other officers for the ensuing year. By their charter, the president and censors have power to convene before them all persons that presume to practise physic within the city of Edinburgh, or the liberties thereof, without the license of the College; and to fine them in five pounds sterling. They are also impowered to visit apothe-

caries' shops, and examine apothecaries themselves; with several other rights and privileges.

College *Sion*, or the College of the London clergy, was formerly a religious house, next to a spittal, or hospital, and now it is a composition of both, *viz.* a college for the clergy of London, who were incorporated in 1631, at the request of Dr. White, under the name of the president and fellows of Sion College; and an hospital for ten poor men, the first within the gates of the house, and the latter without. This College consists of a president, two deans, and four assistants, who are annually chosen from among the rectors and vicars in London, subject to the visitation of the bishop. They have one of the finest libraries in England, built and stocked by Mr. Simpson, chiefly for the clergy of the city, without excluding other students on certain terms; they have also a hall with chambers for the students, generally filled with the ministers of the neighbouring parishes.

College, *Gresham*, or College *of Philosophy*, a College founded by Sir Thomas Gresham, who built the Royal Exchange, a moiety of the revenue whereof he gave in trust to the Mayor and Commonalty of London, and their successors for ever, and the other moiety to the Company of Mercers; the first, to find four able persons to read in the College divinity, astronomy, music, and geometry; and the last, three or more able men to read rhetoric, civil law, and physic; a lecture upon each subject is to be read in term-time, every day, except Sundays, in Latin, in the forenoon, and the same in English in the afternoon; only the music lecture is to be read alone in English.

College *of Heralds*, or College *of Arms*, commonly called the Heralds' Office, a corporation founded by charter of King Richard III. who granted them several privileges, as to be free from subsidies, tolls, offices, &c. They had a second charter from King Edward VI.; and a house built near Doctors' Commons by the Earl of Derby, in the reign of King Henry VII. was given them by the Duke of Norfolk, in the reign of Queen Mary, which house is now rebuilt. This College is subordinate to the Earl Marshal of England. They are assistants to him in his court of chivalry, usually held in the common hall of the College, where they sit in their rich coats of his Majesty's arms.

College *of Heralds* in Scotland. The principal person in the Scottish Court of Honour, is Lyon King at Arms, who has six heralds and six pursuivants, and a great number of messengers at arms under him, who, together, make up the College of Heralds. The Lyon is obliged to hold two peremptory courts in the year, at Edinburgh, on the 6th of May and the 6th of November, and to call officers of arms and their cautioners before him upon complaints; aad if found culpable upon trial, to deprive and fine them and their cautioners. Lyon and his brethren, the heralds, have power to visit the arms of noblemen and gentlemen, and to distinguish them with differences, to register them in their books, as also to inhibit such to bear arms, as by the law of arms ought not to bear them, under the pain of escheating to the King the thing whereon the arms are found, and of a hundred marks Scots to Lyon and his brethren; or of imprisonment during Lyon's pleasure. The College of Heralds are the judges of the malversation of messengers, whose business is to execute summonses and letters of diligence for civil debt, real or personal.

College *of Cardinals*, sometimes called the Sacred College, a body composed of the three orders of Cardinals.

COLLETIA, in botany, a genus of the Pentandria Monogynia class and order. Corolla campanulate, furnished with five-scale-like folds; calyx none; fruit three-grained. One species, found in the Brazils.

COLLIERS, vessels employed to carry coals from one port to another, principally from the northern parts of England to the capital, and more southern parts, and foreign markets. Their trade is known to be an excellent nursery for seamen.

COLLINSONIA, in botany, a genus of the Diandria Monogynia class and order. Leaves ovate, glabrous; stem glabrous. Two species, found in North America.

COLLYRIUM, in pharmacy, a topical remedy for disorders of the eyes.

COLOGNE *earth*, a substance used in painting, much approaching to amber in its structure, and of a deep brown. It has generally been esteemed a genuine earth, but has been discovered to contain a great deal of vegetable matter, and, indeed, is a very singular substance. It is dug in Germany and France: the quantities consumed in painting in London are brought from Cologne, where it is found very plentifully;

but our own kingdom is not without it, it being found near Birmingham, and on the Mendip-hills, in Somersetshire; but what has been yet found there is not so pure or fine as that imported from Cologne.

COLON, the second of the three large intestines, called intestina crassa. See ANATOMY.

COLON, in grammar, a point or character marked thus (:), shewing the preceding sentence to be perfect or entire; only that some remark, farther illustration, or other matter connected therewith, is subjoined. See POINTING, PERIOD, COMMA, &c.

COLONEL, in military matters, the commander in chief of a regiment, whether horse, foot, or dragoons.

COLONEL, *lieutenant*, the second officer in a regiment, who is at the head of the captains, and commands in the absence of the colonel.

COLONNADE. See ARCHITECTURE.

COLONY. A colony is a settlement formed by the inhabitants of any nation in some part of the world, unoccupied by any other civilized nation. The motives for forming them have been various.

In colonies there is generally abundance of good land; hence the necessaries of life are usually to be had in plenty, by any one who will take the trouble necessary to produce them; and, consequently, population usually has a tendency to increase with great rapidity. The inhabitants of some parts of the United States are said to have doubled in fifteen years, at the time those countries were colonies of Great Britain.

The policy of the mother countries with regard to colonies has usually been intended to make the colonists buy the goods of the mother country as dear as possible, and sell their own productions as cheaply as possible. Hence the trade of colonies usually has been confined, by strict commercial laws, wholly to the mother country.

The consequence of these regulations has probably been, that in the colonial trade the merchants and manufacturers have sold their goods dearer, and bought colonial produce cheaper, than they otherwise might have done, though even this may be doubted; but most certainly the inhabitants of the colony have bought dearer, and sold cheaper, than they otherwise would. The prosperity of the colony therefore has been impeded; their progress towards opulence has been less rapid than it would have been under other circumstances; and the mother country has always had a poorer and smaller market for her commodities than she otherwise would have had. The profits per cent. have been perhaps greater, but the whole amount of profit derived from the colony trade has most certainly been less.

COLORIFIC *earths*, in mineralogy, a class or tribe of earths, in the arrangement of Kirwan, described by him as strongly staining the fingers. Of these he enumerates four families, *viz.* red, yellow, black, and green; the red is the reddle. Of dark cochineal red colour, or intermediate between brick and blood red, having neither lustre nor transparency; fracture, earthly, sometimes conchoidal; fragments, 1; hardness, 4; sp. gr. inconsiderable; adhering pretty strongly to the tongue; feeling rough; assuming a polish from the nail; strongly staining the fingers; falling immediately into powder in water, and not becoming ductile; not effervescing, nor easily dissolving in acids. When heated to redness, crackling and growing black; at 159° the specimen melted into a dark greenish yellow frothy enamel. It differs from red ochres only by containing more argil. The red colour proceeds from oxygenation, and the absence of acid. The more air of water is expelled by heat, the browner it grows. The yellow is of an ochre yellow colour; as to lustre, externally it often hath some gloss, but internally none; it is not transparent; fracture earthy, often inclining to the conchoidal; no specific gravity; fragments, inconsiderable; adheres strongly to the tongue; feels smooth, or somewhat greasy; takes a high polish from the nail; strongly stains the fingers; in water it immediately falls to pieces with some hissing; and afterwards to powder, without diffusing itself through it; does not effervesce with acids, nor is easily soluble in them; heated to redness, it crackles, hardens, and acquires a red colour, and gives a reddish streak. At 156°, Mr. Kirwan melted a specimen into a liver-brown porous porcelain mass. This yellow earth differs from ochres only in containing a greater proportion of argil; the yellow colour proceeds from the calx of iron, highly oxygenated, and probably containing both water and acid. Those earths which contain a large proportion of iron have rather an orange colour. According to the analysis of M. Sage of Paris, who has the merit of preserving to his countrymen the immense gains acquired by the Dutch from convert-

ing this yellow earth into what is there called "English red," it contains 50 per cent. argil, 40 oxide of iron, 10 of water, acidulated by sulphuric acid. The 3d family, or black; black chalk is of a greyish black colour; fracture imperfectly curved slaty; fragments partly flat, partly long splintery; adheres slightly to the tongue, feels smooth, assumes a polish from a knife; gives a black streak, and marks black; in water does not readily moulder, but if taken out cracks in a short time; does not effervesce with acids, nor easily dissolve in them; heated to redness, it crackles and becomes reddish grey, and contains somewhat vitriolic. The 4th family, green earth, is of a greyish green colour; found generally in lumps in the cavities of other stones, or externally investing them; fracture, earthy, sometimes uneven, sometimes verging to the conchoidal; sp. gr. 2,637, sometimes feels smooth, does not assume a polish from the knife, nor adhere to the tongue, nor stain the fingers, nor mark while dry, and when wet but lightly, in water it often crumbles after standing about half an hour; does not effervesce with acids, nor is easily soluble in them; heated to redness, it crackles and becomes of a dark reddish cream colour; at 147°, a specimen was melted into a black compact glass, resembling that of basalt; which shews it to consist of silex, argil, iron not much oxygenated, and oxide of nickel, from which the green colour is derived, besides water.

COLOSSUS, a statue of enormous or gigantic size. The most eminent of this kind was the colossus of Rhodes, one of the wonders of the world, a brazen statue of Apollo, so high, that ships passed with full sails betwixt its legs. It was the workmanship of Chares, a disciple of Lysippus, who spent twelve years in making it: it was at length overthrown by an earthquake, B. C. 224, after having stood about sixty-six years. Its height was a hundred and five feet: there were few people who could encompass its thumb, which is said to have been a fathom in circumference, and its fingers were larger than most statues. It was hollow, and in its cavities were large stones employed by the artificer to counterbalance its weight, and render it steady on its pedestal.

On occasion of the damage which the city of Rhodes sustained by the abovementioned earthquake, the inhabitants sent ambassadors to all the princes and states of Greek origin, in order to solicit assistance for repairing it; and they obtained large sums, particularly from the kings of Egypt, Macedon, Syria, Pontus, and Bithynia, which amounted to a sum five times exceeding the damages which they had suffered. But instead of setting up the Colossus again, for which purpose the greatest part of it was given, they pretended that the oracle of Delphos had forbidden it, and converted the money to other uses. Accordingly the Colossus lay neglected on the ground for the space of 894 years, at the expiration of which period, or about the year of our Lord 653, or 672, Moawyas, the 6th caliph or emperor of the Saracens, made himself master of Rhodes, and afterwards sold their statue, reduced to fragments, to a Jewish merchant, who loaded 900 camels with the metal, so that, allowing 800 pounds weight for each load, the brass of the Colossus, after the diminution which it had sustained by rust, and probably by theft, amounted to 720 thousand pounds weight. The basis that supported it was of a triangular figure: its extremities were sustained by sixty pillars of marble. There was a winding staircase to go up to the top of it; from whence one might discover Syria, and the ships that went to Egypt, in a great looking-glass that was hung about the neck of the statue. This enormous statue was not the only one that attracted attention in the city of Rhodes. Pliny reckons 100 other colossuses not so large, which rose majestically in its different quarters.

COLOUR means that property of bodies which affects the sight only; thus the grass in the fields has a green colour, blood has a red colour, the sky generally appears of a blue colour, and so forth; nor can those colours be distinguished by any of our other senses besides the sight. The variety of colours, as they are presented to us by the substances that surround us, is immense, and from them arises the admirable beauty of the works of nature in the animal, in the vegetable, and in the mineral kingdom, or, more properly speaking, in the universe. The science which examines and explains the various properties of the colours of light and of natural bodies, and which forms a principal branch of optics, has been properly denominated chromatics. See CHROMATICS.

COLOUR, in *heraldry*, the heraldic colours are nine, and were anciently expressed by the word tincture; *viz.* or, argent, azure, gules, sable, vert, purpure, tenney, and sanguine; and also by precious stones and

planets; the armorial colours are blazoned in different terms, according to the rank and dignity of the person whose arms are described, as follows:

Colours.	For commoners by tinctures.	For peers by precious stones.	For emperors, kings, and princes, by planets.
Yellow...........	Or.................	Topaz............	Sol.
White	Argent...........	Pearl.............	Luna.
Blue...............	Azure	Sapphire..........	Jupiter.
Red	Gules.............	Ruby..............	Mars.
Black	Sable	Diamond.........	Saturn.
Green.............	Vert...............	Emerald..........	Venus.
Purple...	Purpure...........	Amethest.........	Mercury.
Orange............	Tenney...	Jacinth...........	Dragon's head.
Dark red.........	Sanguine	Sardonix	Dragon's tail.

Or and argent are metals; and it is an invariable rule in heraldry not to put colour upon colour, or metal on metal; that is, if the field be of a colour, the charge or bearing must be of a metal.

Colour, in law, is a probable or plausible plea, though in reality false at bottom, and only calculated to draw the trial of the cause from the jury to the judge; and therefore colour ought to be matter of law, or doubtful to the jury.

In pleading it is a rule that no man be allowed to plead specially such a plea as amounts only to the general issue; but in such case he shall be driven to plead the general issue in terms by which the whole question is referred to a jury. But if a defendant in an assize, or action of trespass, be desirous to refer the validity of his title to the court rather than to the jury, he may state his title specially, and at the same time give colour to the plaintiff; or suppose him to have an appearance or colour of title, bad indeed in point of law, but of which the jury are not competent judges.

Colour, in calico-printing. The term colour in calico-printing is applied not only to those vegetable, animal, and mineral solutions, which impart their own colour to the cloth on which they are applied; but also improperly to those earthy or metallic solutions, which, possessing little or no tingent properties themselves, yet retain or fix the qualities (colours) of other substances when afterwards applied to the cloth. Thus the acetite of alumina, or printers' red liquor, when pure, is almost colourless, and only becomes red by the process of dyeing, as will be explained hereafter. The acetite of iron, or iron-liquor, in like manner, when used of a determinate strength, is called black colour, and when weaker purple colour, though the cloth impregnated with these solutions becomes black or purple only as being raised like the other in the dye-copper. 1. The colours produced by means of these earthy or metallic solutions (which, in the language of science, are called mordants) form the most valuable and important series, whether considered with regard to the almost infinite variety of shades, or to their solidity and durability. These colours, from the mode in which they are produced, (the mordant being first applied to the cloth, and the colour afterwards raised by dyeing) are called dyed colours. 2. Sometimes the mordant is previously mixed with a solution of colouring matter, and in that state applied to the cloth, so as to paint or stain it at one operation, and without the process of dyeing. Thus another class of colours is produced, many of them possessing great brilliancy indeed, but much inferior to the former in durability. The colours called chemical by calico-printers belong chiefly to this class. 3. In the third and last class we may place all those where the colouring matter is simply held in solution by an acid or alkali, and in this state applied to the cloth without the intervention of any mordant. To one or other of the foregoing classes may be referred all the colours used in calico-printing, with the exception, however, of those systems of colours which have been produced by calico-printers in this country, within a short period, by processes and upon principles which have hitherto not been made known. See Calico Printing.

Colour *of the clouds* is thus accounted for by Sir Isaac Newton. Concluding from a series of experiments, that the transparent parts of bodies, according to their se-

veral sizes, reflect rays of one colour and transmit those of another, he hence observes, that when vapours are first raised they are divided into parts too small to cause any reflection at their surfaces, and therefore do not hinder the transparency of the air; but when they begin to coalesce, in order to form drops of rain, and constitute globules of all intermediate sizes, these globules are capable of reflecting some colours, and transmitting others, and thus form clouds of various colours, according to their sizes. Mr. Melville controverts this doctrine, in its application to the red colour of the morning and evening clouds. "Why," he says, "should the particles of the clouds become at that particular time, and never at any other, of such a magnitude as to separate these colours? And why are they rarely, if ever, seen tinctured with blue and green, as well as red, orange, or yellow? Is it not more credible, that the separation of rays is made in passing through the horizontal atmosphere, and that the clouds only reflect and transmit the sun's light, as any half-transparent colourless body would do? For since the atmosphere reflects a greater quantity of blue and violet rays than of the rest, the sun's light transmitted through it ought to incline towards yellow, orange, or red; especially when it passes through a long tract of air: and thus it is found, that the sun's horizontal light is tinctured with a deep orange, and even red; and the colour becomes still deeper after sun-set." Hence he concludes that the clouds, according to their different altitudes, may assume all the variety of colours at sun-rising and setting, by barely reflecting the sun's incident light as they receive it.

Colours. This very important article includes a variety of matters of peculiar interest to various professions, and requiring no inconsiderable portion of study. We have only seven natural colours, namely, red, orange, yellow, green, blue, indigo, and violet. See Chromatics.

The mechanical use of colours is more immediately under our present consideration. These are either what are called body or transparent: the former applies to such as have a certain substance, being like very thin paste, and coating the object to which they are applied: these are again divided into oil and water colours. Transparent colours are made either of expressed juices, corrected by inspissation, or of the finer particles of earths, gums, &c. highly prepared by levigation, washing, &c.

Oil colours are made by mixing the colouring substances with prepared oils; that is, such as dry readily, and are at the same time so fine and transparent as not to injure the brilliancy or clearness of the colour. Nut-oil is on this account highly esteemed; but in a recent publication (the seventh number of the Agricultural Magazine) we are informed, that sun-flower oil possesses qualities of great moment to the painter, and to various other artists. The colouring matter must be minutely mixed with the oil, so that it may work perfectly free and smooth.

Body colours for the limner's use should be prepared of the purest materials, and be triturated in a mortar, and on a slab with water, until such time as the mixture is completely smooth, and leaves no roughness when rubbed between the thumb and fore-finger: not, however, without making allowance for some particular substances, especially minerals, which, however well they may have been prepared, will occasion a roughness to the touch. Body colours are usually sold in bottles, ready mixed to their proper consistence, and sometimes in cakes, with a small portion of gum Arabic dissolved in the water. Oil colours are most frequently sold in kegs, and ready ground, but requiring an addition of oil before they can be worked: these are generally for the use of house painters, &c.; those for the more delicate purposes are usually kept in bladders.

Transparent colours should be so clear, when mixed with abundance of water, as to communicate a strong tint without in the smallest degree plastering or concealing the paper, &c.: hence their designation. The best of every kind are made from either vegetable or animal substances; minerals being extremely difficult to prepare, equally so to work with water, and many of them very subject to change. We shall give a concise account of the materials in general use; observing, that there are an immense number of compound colours, sold under various names, that may be made from the following list of simples:

REDS.

Carmine, or the extract of cochineal. Excellent.

Florentine lake, made from refuse cochineal, with a small addition of Brazil wood, precipitated by adding a solution of tin. Does not stand.

Madder lake, the same as the foregoing,

but sometimes with the addition of extract of madder. Stands.

Rose lake, or rose pink, made of chalk tinctured with extract of Brazil wood. Does not stand.

Vermillion is a bright scarlet, made from livigated cinnabar. Very apt to turn black.

Red-lead, or minium, levigated, also turns black.

Indian red, an ochre brought from Asia, forms a beautiful bright brick red. Works freely and stands well.

Venetian red is a coarser substance, usually employed with size, or oil, to imitate mahogany.

Light red. This is yellow ochre heated until it changes. Stands well, and is much used.

Red chalk is generally cut into slips, and used as a crayon. It must be very well ground, when it works and stands well, either with oil or water.

Burnt terra sienna is raw sienna calcined till it becomes a fine mellow red. It is in high estimation for its richness, smoothness, and stability.

Orange is usually a compound colour, but may be made from red orpiment, and from an infusion of turmeric in spirits of wine, with a solution of tin.

YELLOWS.

Indian yellow, made from chalk impregnated with urine, whereby it in process of time acquires a very strong colour. It is offensive to the smell, and soon fades.

King's yellow is a strong poison; the basis being yellow orpiment, ground very fine. The colour is very rich, but does not stand.

Naples yellow comes from that country: is prepared from lead and antimony. It turns black, especially if in contact with iron.

Yellow ochre, or Roman ochre, an earth coloured by oxide of iron. It is dull, but stands well.

Massicot is oxide of lead—very dull, but stands.

Dutch pink is chalk coloured with French berries. The colour is beautiful, but soon flies.

Gamboge is a gum very acrid, but highly useful. It stands well, mixes freely, and gives a rich gloss; but it does not answer with oil.

Gall-stones are calculi, or stones taken from the gall-bladders of animals. See Calculi. This colour may be obtained from the gall itself. It is superb, but apt to fly.

Turmeric and *saffron* yield a pleasing colour, as does *annatto*, but very volatile.

BROWNS.

The finest we have is taken from a small bag found in the entrails of the cock-chaffer.

Bistre is the extract of soot from burnt wood. It stands admirably, and is a very useful as well as clear colour. It is much used for sketches, to which it gives a warm appearance.

Cologne earth, a deep brown, very useful, made from an ochre said to be from Cologne, but often spurious.

Raw umber, a light-brown ochre that stands well.

Burnt umber, the former calcined, thence acquiring a much richer tint, that stands admirably and is much in use.

Asphaltum is a bituminous substance, which being dissolved in turpentine, gives a rich deep brown, not unlike that of tar: it is used for finishing and for glazing pictures.

Brown pink is made of chalk, coloured with fustic, and heightened by fixed alkaline salts, which render it extremely volatile.

Tobacco juice makes a very rich colour, which, mixed with alum, will stand well: it is peculiarly warm and transparent.

BLACKS.

Indian ink is supposed to be made from the gall of the cuttle-fish, but by many is said to be nothing more than a peculiar kind of charcoal, or the soot collected from burning a species of the acacia. In fact, we only know, that it should be black, smooth, and glossy when broken; and that it makes remarkably fine black: some, indeed, have a brownish tint. What is made in England is coarse, rough, gritty; and generally has a bluish cast.

Lamp black is the soot of oil, collected by means of inverted vessels placed over the flames; it is incomparably smooth, and stands well; but is not very deep.

Ivory black is made of ivory, bones, &c. exposed to great heat in a well luted crucible. It is a very deep, but a cold colour.

Blue black is made from vine stalks prepared as above: its colour is deep, but with a bluish cast.

BLUES.

Indigo is the extract from a plant of that

namé: it is a cold, but permanent colour: it is not miscible with water, but gives way to the sulphuric acid.

Prussian blue is made with two parts of purified potash well mixed with one of dried bullock's blood levigated: these are calcined in a covered crucible, with a moderate fire, until they cease to emit fumes.

Blue verditer is made by absorbing the copper dissolved in aqua fortis, by aid of whitening.

Smalt is pounded zaffre, made from the ore of zinc.

Brice is levigated smalt, and rather lighter.

All the above colours are very durable.

PURPLE.

The *Crocus-martis* gives a simple purple, which colour may also be obtained from logwood, with a solution of tin.

GREENS.

Verdigris is an incrustation of copper by the corrosion of acids: it is highly poisonous; but gives a beautiful green colour, with a very slight bluish tinge: when boiled with vinegar, in an earthen vessel, it gives a highly transparent colour, fit for washing brass, &c.; but this is very apt to fade.

Sap-green is the concreted juice of the buckthorn berry: it is a dull green, and is much in use though apt to fade.

WHITES.

Flake-white is an oxide of lead, formed by corrosion of that metal with vegetable acids.

White lead is the same as the above, but coarser; it is not so good as flake white, often turning black.

Pure carbonate of lime stands perfectly well, and is much used: it is by some called Spanish white, and is nearly the same as the pigments produced from egg shells, or oyster shells, calcined.

Calcined hartshorn is an excellent white.

The above catalogue of colours is intended for the service of those who apply them with the brush, as in oil-painting, and in limning. The colours used by dyers are very different, and are chiefly pastil, woad, and indigo, for blues; cochineal, carthamus, gum-lac, archil, logwood, madder, &c. for red; weld, savory, quercitron, fenu-greek, &c. for yellows; walnut bark, or rind, alder bark, sandal-wood, sumach, and soot, are used for browns, or, as they are technically called, fawn-colours; for black, galls, copperas, &c.; greens are generally compounds made from blue and yellow; purples from blue and red; orange colour from red and yellow; and many shades are made by the mixture of red and black, black and blue, &c.; yellow and red also give an olive colour. See DYEING.

COLOURS *diatonic*, or *musical scale of.* In the course of Sir Isaac Newton's experiments on the properties of light, he discovered the remarkable fact, that the spectrum of the sun's image, formed by refracted light, let into a darkened room, is longitudinally divided by the points separating the different colours; *viz.* violet, indigo, blue, green, yellow, orange, and red, into spaces which are respectively equal to $\frac{1}{9}$, $\frac{1}{18}$, $\frac{1}{12}$, $\frac{1}{12}$, $\frac{1}{15}$, $\frac{3}{80}$, and $\frac{1}{16}$ parts of the double length of the spectrum; as, suppose the spectrum to be 360 parts in length, then $\frac{80}{720}$, $\frac{40}{720}$, $\frac{60}{720}$, $\frac{60}{720}$, $\frac{48}{720}$, $\frac{27}{720}$, and $\frac{45}{720}$, will represent the length of each colour respectively, and adding these successively in the reverse order, to $\frac{360}{720}$, we have $\frac{405}{720}$, $\frac{432}{720}$, $\frac{480}{720}$, $\frac{540}{720}$, $\frac{600}{720}$, $\frac{640}{720}$, and $\frac{720}{720}$, which, in their lowest terms, are $\frac{1}{2}$, $\frac{9}{16}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{8}{9}$, and 1, and appear to be the diatonic ratios answering to the octave, minor seventh, major sixth, fifth, minor fourth, minor third, major second, and key note.

From the experiments of Henry Broughton, jun., Esq., "Philosophical Transactions, 1796," it appears, that not only by refraction, but by inflection, deflection, and reflection, the rays of light may be separated on a chart or screen: and he mentions numerous experiments, wherein the limits of the several colours on the spectrum were carefully marked with the point of a needle, after which the papers thus marked were put away, and a fresh paper substituted for other experiments: the measurement or comparison of the lengths of the intervals occupied by each colour on the different papers, being purposely deferred, until the whole course of experiments was completed, in order to prevent any preconceived opinions from operating, in making the experiments: the results are represented as agreeing, in the spaces, $\frac{1}{9}$, $\frac{1}{18}$, $\frac{1}{12}$, $\frac{1}{12}$, $\frac{1}{15}$, $\frac{3}{80}$, and $\frac{1}{16}$, occupied by the violet, indigo, blue, green, yellow, orange, and red colours, being the very same, as to arrangement, as those by refraction above-mentioned.

COLOUR *of office*, signifies some unjust action done under countenance of an office, and is opposed to *virtute officii*, which im-

plies a man's doing a right and just thing in the execution of his office.

COLOURS, in the military art, include the banners, flags, ensigns, &c. of all kinds, borne in the army or fleet. See ENSIGN, FLAG, PENDENT, and STANDARD.

COLOURING, in painting, one of the great component and essential parts of painting is the art of giving to every object in a picture its true and proper hue, as it appears under all the various circumstances or combinations of light, middle-tint, and shadow; and of so blending and contrasting the colours, as to make each appear with the greatest advantage and beauty, at the same time that it contributes to the richness, the brilliancy, and the harmony of the whole. It likewise possesses powers which, when judiciously applied, render it highly conducive to the character and expression of the subject represented. See PAINTING.

COLOURING *matter*. It has been supposed, that a peculiar proximate principle exists in vegetables, in which their colour frequently resides, and which has hence received the name of colouring matter.

The colouring matter of vegetables is scarcely ever found insulated, but is mixed or combined with other principles. In this state it exists in the leaves and flowers, in the bark and in the wood of the stem and roots. It is extracted, and obtained more pure, by the action of those agents which are capable of dissolving it. In many cases, water, cold or warm, is sufficient for this purpose. If logwood, brazil wood, madder, weld, or quercitron bark, for example, be macerated in water, the matter on which the colour depends is dissolved; a transparent solution, more or less deeply coloured, is obtained; and, by repeating the maceration with water sufficiently, nothing at length remains but the mere ligneous fibre. Sometimes, however, the colouring matter is not soluble in water: it is then frequently soluble in alcohol; and in a few substances, is even best dissolved by oils essential or expressed.

When the colouring matter is in solution, it may be attracted from the solvent by other substances with which it enters into combination: and this, in some measure, gives it a more appropriate character. There are some substances even which appear in general to exert strong affinities to colouring matter, particularly alumina and some of the metallic oxides. If alumina be diffused or boiled in a coloured vegetable infusion, it often happens, that the colouring matter combines with it, and leaves the water of the infusion perfectly colourless. Or if alum be dissolved in a coloured infusion, and it be decomposed by the addition of an alkali, the alumina in the moment of its precipitation attracts the colouring matter, forms a coloured precipitate, and, if the due proportions have been observed, the liquid will remain colourless. In like manner if a coloured infusion be boiled with a metallic oxide, it often happens that the colouring matter is attracted by the oxide. Thus Berthollet obtained combinations by this process of the colouring matter of logwood, and other dye-stuffs, with oxide of copper and oxide of tin. Or if certain metallic salts be dissolved in the infusion, and be then decomposed by an alkali, the oxide in precipitating equally atttracts the colouring matter. It is from similar affinities to the colouring matter that it is often attracted by linen, cotton, silk, or wool, from its solutions; and even where the affinities of these are not sufficiently powerful, they may be rendered capable of attracting it, or the combination may be rendered more permanent by their being impregnated with another substance, which has towards it a still stronger attraction. See DYEING.

COLPODA, in natural history, a genus of the Vermes Infusoria: worm, invisible to the naked eye, very simple, pellucid, flat-sinuate. There are seven species, of which C. lamella, in water, resembles a long narrow pellucid membrane, narrower and obtuse behind, curved towards the top, with a ridge or fold going through the middle: it moves to and fro on its edge, and not on the flat side.

COLUBER, in natural history, a genus of serpents distinguished by having plates on the belly, and scales on the under parts of the tail. The species of this genus are numerous. Linnæus describes, upon the testimony of various writers, above ninety; and that number even has been considerably augmented by naturalists since his time. The species differ greatly in size and habit; some, as the vipers having the head large, flattish, and semi-cordated, with the body and tail of a moderate length, or rather short; while others, as the greater part of the harmless serpents, have small heads, with the body and tail much longer in proportion. In some, exclusive of the usual scales under the tail, are a few scuta or undivided lamellæ, either at the beginning or towards the tip of the tail.

Linnæus considered the number of abdominal plates and scales under the tail, as a characteristic distinction of the different species of this genus; such, however, is the inconsistency of this criterion, that, in describing the same species, scarcely two writers agree. Characters taken from the number of those plates and scales in the serpent tribe, like those from the number of rays in the fins of fishes, are not to be relied upon. The colours are liable to some variation; but the peculiar form and disposition of the spots, lines, and other markings, afford, in general, a character by which the different species may be distinguished.

C. vipera. Somewhat ferruginous, spotted with brown; beneath whitish; tail short and mucronated. Abdominal scuta 118, subcaudal scales 22. Linnæus. This is the common viper of Egypt; it is imported in considerable quantities every year to Venice for the use of the apothecaries. Its size is somewhat smaller than that of the common viper; the head not so flat on the top, but very protuberant on each side; snout very obtuse. The body is thick towards the middle, and somewhat quadrangular, but thin and cylindric towards the head and tail, which last is short, slender, conical, and terminated by a slightly incurved horny point or tip. The scales on the upper parts are oval and carinated. Hasselquist describes this species as being about two spans in length, exclusive of the tail, which measures only an inch. This is supposed by some to be the asp, by the bite of which the celebrated Cleopatra determined rather to die than submit to be carried captive to Rome, to grace the triumph of Augustus.

C. berus. On the head a bilobate spot; body above cinerous (or reddish) with a black flexuous zig-zag stripe down the back, and belly purplish. Coluber berus, abdominal scuta 146, subcaudal scales 39, Linnæus. This is the common English viper, and which is not only frequent in this country, but appears to be generally diffused over the rest of Europe, and some parts of Asia. If the varieties, described by Gmelin, are of the same species, it extends also as far as India.

Though the viper varies considerably in colour, from a pale cinerous or yellowish ferruginous, to deep or dull brown, the varieties agree in being marked with a continued series of confluent rhomboid blackish spots, extending from the head to the tail. The general length of the viper is from eighteen inches to two feet, and it is affirmed by some writers to grow even to the length of three feet. The fangs of the viper, like those of other poisonous serpents, are situated on each side the fore part of the upper jaw, and are generally two in number, with a few smaller ones situated behind. The poison, as usual, lies in a receptacle at the base of the fangs, and being perforated, when the animal bites, the compression of those receptacles forces out a drop of the poisonous fluid, which passing through the aperture of the fangs is immediately instilled into the wound. The tongue is forked, and being soft and flexible is susceptible of great extension: it may be, perhaps, superfluous to add, that this tongue is altogether incapable of inflicting any wound, or injecting poison, as some ancient writers credulously affirm; it may assist the animal in the capture of its insect prey. The French naturalists are inclined to believe it is intended by nature to supply some defect of transpiration in the skin. Hitherto the viper has been considered the most poisonous of the European serpents, and many instances are recorded of the fatal effects resulting from its bite. That the bite of this serpent is always productive of pain and temporary inflammation in the parts bitten, is very evident; sometimes also the symptoms may become alarming, or, in a few instances, through neglect or injudicious treatment of the wound, may even prove fatal; but upon the whole, the bite of this creature does not appear pregnant with all those dangers which the terrors and prejudices of the vulgar lead them to suppose. In England the bite of the viper is rarely attended with fatal consequences. Fontana seems to doubt whether any well attested instance can be adduced of the viper having killed any person by its bite, even in the warm climate of Italy. The testimonies of authors, both as to the nature of the poison itself, and its effects on the animal frame, are, however, confessedly at variance.

The viper, though so much dreaded on account of its bite, has been very highly esteemed both by the ancients and moderns as a restorative and strengthening diet. The ancients used the flesh of this snake in leprous and other cases. The Greek physician Craterus, cured, as Por-

phyrius relates, a miserable slave, whose skin in a strange manner fell off from his bones, by advising him to feed on vipers' flesh in the manner of fish. Galen says, that those afflicted with elephantiasis are wonderfully relieved by eating vipers' flesh dressed like eels, and relates very remarkable cures of this disease performed by means of viper wine. In France and Italy, the broth, jelly, and flesh of vipers are in much esteem as a restorative medicine. In England we have to instance the well known circumstance of Sir Kenelm Digby, who caused his wife, Lady Venetia, to feed on capons fatted with vipers to recover her from a consumption.

The viper abounds most in dry, stony, and chalky countries, or in the low herbage or underwood in thickets. It casts its skin twice in the year, namely, in spring and autumn, and is said to attain its full size at the age of six or seven years, but is capable of engendering when two or three years old.

COLUMBA, the *pigeon*, in natural history, a genus of birds of the order of Passeres. Generic character: bill weak, straight, descending towards the tip; nostrils oblong, and half covered with a soft tumid membrane; tongue entire; legs short, and generally red; toes divided to their origin. Latham enumerates no less than 66 species, and Gmelin mentions even 82, besides considerable varieties. We shall confine our notices to the few which follow.

C. domestica, or the common pigeon. Of these birds vast flocks arrive in England every year from the northern climates, to which they return on the advance of spring. Many, however, remain in the wild and mountainous districts of this island during the whole year, and breed in the clefts of rocks, or the ruins of human habitations, or in the decayed parts of trees. From this wild state they are easily induced to inhabit the dove-house, which is the first stage of domestication, and near which they find, in vast abundance, and within a small compass, all those conveniences which, in tracts far from human habitation, they can collect only from a considerable distance, and with extreme difficulty. From this accommodation by man, however, there is perpetual danger of their recurring to their former state of freedom, in which though their means of subsistence are more scanty, they are less subject to alarms. The wild pigeon breeds only twice in a year, but its prolific tendencies increase in proportion to its degree of domestication; and when that is complete, it will lay even every month, but scarcely ever more than two eggs, containing, generally, a male and female bird. The flesh of this bird is highly valued for the table. Its dung is considered, for some species of land, as a most admirable manure, and it is of considerable service also in tanning skins for shoe leather. In Egypt a pigeon-house is considered as an indispensable part of every complete farming establishment, and in the capital of Persia there are reported to be 3000 of these buildings, the privilege of keeping which is denied to Christians in that country. An efficacious inducement for pigeons to remain in any particular spot is furnished by a mixed heap of loam, rubbish, and salt. Incubation is performed among these birds alternately by the male and female; and the young are fed from the mouths of the old parents, who are said, for this purpose, by contracting some particular muscles, to draw up the provisions which they have swallowed. Pigeons have been occasionally used for the conveyance of letters, in cases in which intercourse between the parties was extremely difficult; the bird is to be taken from the places to which the intelligence is to be sent, and when liberated will return to its destination with great rapidity, with the interesting billet under its wing. There are few or no cases, however, which now compel recourse to so operose and doubtful an expedient.

C. palumbus, or the ring dove. These are found in almost all parts of Europe. They depart from England, however, towards the close of the year, and are absent till the spring. They build large and ill-compacted nests in the tops of trees, and avoid the habitations of men. They are one of the largest species of the pigeon, their length being rather more than seventeen inches. See Aves, Plate IV. fig. 6.

C. turtur, or the turtle-dove. These arrive in England later than any other migrating pigeon, and depart earlier. During their short stay in this country they are to be seen, not unfrequently in Kent, in flocks of about fifteen or twenty, and commit no small depredations on the pea fields of that county, peas being their most favourite food. They build generally in the woods, and on the highest trees. The sounds of the male are particularly soft and impressive, and his assiduity to please the companion of his joys and cares has induced the poets of every age to exhibit him as a mo-

del of pure, constant, and delicate attachment. See Aves, Plate IV. fig. 7.

C. migratoria, or the American migratory pigeon. These birds pass the summer in the northern parts of North America, and on the approach of winter move towards the southern. They build in trees, and feed principally upon acorns, and mast of every description. They are also extremely fond of rice and corn. They pass in their periodical migrations in flocks, stated to extend in length two miles, and a quarter of a mile in width; occasionally alighting in the course of their journey, and covering the foliage of considerable woods. During what is called their flight time, the common people of the country easily knock them from their roosts, and find them a very nourishing and pleasant, as well as cheap article of food. In Louisiana it is a common entertainment in an evening, in which ladies frequently participate, to enter the woods frequented by these birds, and burn a small quantity of sulphur under the trees on which they are lodged. Stupefied by this application, they almost immediately quit their hold, and drop lifeless to the ground, whence they are picked up in quantities.

C. œnas inhabits old turrets, and rocky banks of Europe and Siberia. fig. 2.

COLUMBATES. }
COLUMBIC *acid*. } See COLUMBIUM.

COLUMBIUM, in mineralogy and chemistry. Mr. Hatchet, in examining some minerals in the British Museum, observed one which attracted his attention, from its resemblance to chromate of iron. On analysing it, he found it to be composed of a metallic acid, united with oxide of iron; and this acid, by farther experiments, was found to differ in its properties from every other. Mr. Hatchet did not succeed in reducing it to the metallic state. To the metal, however, which he supposed to be its basis, he gave the name of Columbium, as the ore affording it was the produce of America. The mineral which afforded this metallic acid is of a dark brownish-grey colour; its lustre is vitreous, inclining to metallic: its fracture imperfectly lamellated: it is moderately hard and very brittle: its particles are not attracted by the magnet: its specific gravity is 5.9. From this mineral Mr. Hatchet extracted the peculiar matter which may be named columbic acid. The columbic acid is of a pure white colour, and not extremely heavy; it has scarcely any taste, nor does it appear to be soluble in boiling water, but, when placed on litmus paper, mixed with distilled water, soon renders the paper red.

From the acid solutions of columbic acid, the alkalies throw it down in the form of a white flocculent precipitate. Prussiate of potash changes the colour to an olive-green, and a precipitate of the same colour is gradually formed. Tincture of galls produces a deep orange-coloured precipitate, especially when there is not too great an excess of acid present. Zinc immersed in the solution, gives rise to a white precipitate. The fixed alkalies combine readily both in the humid and in the dry way with columbic acid, forming with it salts called columbates. When fused with it, a compound is formed, which is soluble in water; and if the alkali be in the state of carbonate, the carbonic acid is disengaged during the fusion with effervescence. When a solution of potash is boiled on it, a quantity is dissolved; the solution, which has a considerable excess of alkali, affords, by gentle evaporation, a white salt in shining scales, having a disagreeable acrid flavour, not soluble very readily in cold water, but, when dissolved, the solution is permanent. Nitric acid added to it precipitates the columbic acid. Prussiate of potash and tincture of galls produced no change; but when with either of them a few drops of muriatic acid were added, precipitates similar to those produced by these re-agents in the acid solutions, appeared an olive green with the one, and an orange-coloured precipitate with the other. Hydro-sulphuret of ammonia produced a reddish brown precipitate.

This substance is possessed of properties different from any of the known metals or metallic oxides or acids; for although in some qualities it approaches to titanium, tungsten, or to molybdena, it differs from them, and from all the others, particularly in the precipitates it affords with prussiate of potash and tincture of galls, in not combining with ammonia, and in being insoluble, and unalterable with regard to colour by nitric acid.

COLUMELLA, in botany, a genus of the Syngenesia Superflua class and order: receptacle naked, cellular; seeds crowned with a toothed margin; calyx cylindrical, imbricate; florets of the ray undivided. One species, found at the Cape.

COLUMN, a round pillar, made to support and adorn a building, and composed of a base, a shaft, and a capital.

AVES.

Fig. 1. **Ardea** *virgo: Numidian Crane. Fig.* 2. **Columba** *oenas: stock pigeon. Fig.* 3d **Certhia** *sannio: mocking creeper. Fig.* 4. **Charadrius** *oedicnemus: Great Plover. Fig.* 5. *C. pluvialis golden Plover. Fig.* 6. **Columba** *palumbus: Ring dove. Fig.* 7. *C. turtur: turtle dove.*

Columns are different in the different orders of architecture, and may be considered with regard to their matter, construction, form, disposition, and use. See ARCHITECTURE.

COLUMNEA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla ringent; upper-lip three-parted, the middle part vaulted, emarginate; gibbous above at the base; anthers connected; capsule two-celled; seeds nestling. There are six species, all natives of hot countries, and most of them of the West Indies.

COLUMNIFERÆ, in botany, the name of the thirty-seventh order in Linnæus's "Fragments of a Natural Method," consisting of plants whose stamina and pistil have the appearance of a pillar in the centre of a flower: an instance of this order is the genus BIXA, which see.

COLURES, in astronomy and geography, two great circles supposed to intersect each other at right angles in the poles of the world, and to pass through the solstitial and equinoctial points of the ecliptic. That which passes through the two equinoctial points is called the equinoctial colure, and determines the equinoxes; and the other which passes through the poles of the ecliptic is called the solstitial colure, because it determines the solstices.

COLUTEA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-cleft; legume inflated, gaping on the upper suture at the base. There are nine species. Most of the Coluteas are shrubs, with pinnate leaves, and stipules distinct from the petiole; peduncles sometimes two-flowered, but more frequently many-flowered in spikes, both axillary and terminating. They are easily distinguished by their membranaceous, inflated pod; natives of hot climates.

COLYMBUS, the *diver*, in natural history, a genus of birds of the order Anseres. Generic character: bill toothless, subulate, straight, and pointed; throat toothed; nostrils linear; legs fettered. The guillemot and the diver are included by Gmelin under one genus, while Latham considers each as furnishing a genus by itself. We shall adopt the system of the former, and notice, in what follows the most important species of these two classes, under one head.

C. troile, or foolish guillemot. These birds are, in summer, surprisingly abundant on the coasts of England, and furnish to the sportsman an invaluable supply of experience in the art of shooting flying. Whatever numbers may be destroyed, the rest only quit their stand to take a circular flight which brings them back to the spot whence the gun alarmed them, and which the death of their companions cannot induce them finally to leave. Their flesh is eaten by the Kamschatkans, though extremely ill-flavoured, and their skins are valued by those people as a highly ornamental dress. The eggs are said to be extremely delicate, and it is remarkable that no two are spotted or streaked alike.

C. glacialis, or the Northern diver, is the largest of the genus, and weighs so much as sixteen pounds, measuring three feet six inches in length. This is found in various places in the North of Europe, but scarcely ever even so far south as England, unless in winters extremely rigorous. It is rarely seen on land, being almost perpetually on the ocean, where it dives with extreme vigour in pursuit of various fishes, and with such dexterity as rarely fails of success. It can fly with rapidity, and to a great distance. In Iceland it is often found, and, while breeding, frequents the lakes and rivers of that island. The inhabitants of the banks of the Oby prepare the skin of this bird without injuring the feathers, and render it convertible into compact, durable, and ornamental parts of dress, as caps or even mantles, which are proofs against moisture, and afford extraordinary warmth.

C. immer, or the imber, resembles the last in habits and manners. It is found in the lakes of Canada, and in those of Switzerland, as well as in almost all the northern parts of Europe. It will swim under water to the distance of a hundred paces, and is caught by land or in the water with extreme difficulty. By a hooked line however, baited with its favourite fish, it has often been drawn up from a considerable depth, and thus exhibited to many observers a singular variety from the sportsman's usual practice.

COMA, or COMA-VIGIL, a preternatural propensity to sleep, when nevertheless the patient does not sleep, or if he does, awakes immediately without any relief. See MEDICINE.

COMA, in botany, a collection of floral leaves, which, in the crown imperial, lavender, sage, cow-wheat, and some other

plants, terminate the flower-stem, and form an appearance like a tuft of hair.

COMA *Berenices*, *Berenice's hair*, in astronomy, a constellation of the Northern hemisphere, composed of stars near the Lion's Tail. See ASTRONOMY.

COMARUM, in botany, a genus of the Icosandria Polygamia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten-cleft; petals five, smaller than the calyx; receptacle of the seeds ovate, spongy, permanent. There is but one species; *viz.* C. palustre, marsh-cinquefoil, a native of most parts of Europe, in boggy ground.

COMB, an instrument made of horn, ivory, tortoise-shell, box, or holly-wood, &c. and useful for separating and adjusting the hair, &c.

COMB *making*. Combs are not only made for the purpose of cleansing the hair, but for ornament: they are sometimes set with brilliant stones, pearls, and even diamonds; some again are studded with cut steel; these are of different shapes, and are used to fasten up the hair when ladies dress without caps. Combs may, of course, be had of all prices, from the value of a few pence to almost any sum. They are generally made of the horns of bullocks or of elephants, and sea-horses teeth, and some are made of tortoise-shell and ivory, others of box or holly-wood. The horns of bullocks are thus prepared for this manufactory: the tips are sawn off; they are then held in the flame of a wood fire; this is called roasting, by which they become nearly as soft as leather. While in that state they are slit open on one side, and pressed in a machine between two iron plates; they are then plunged into a trough of water, from which they come out hard and flat; they are then sawn into lengths, according to the size wanted. To cut the teeth, each piece is fixed into a tool called a claw. The maker sits on a triangular sort of a stool to his work, and under him is placed the claw that holds the horn, ivory, &c. that is to be formed into a comb. The teeth are cut with a fine saw, or rather a pair of saws, and they are finished with a file. A coarser file, called a rasp, is used to reduce the horn, &c. to a proper thickness; and when they are completely made, they are polished with charcoal and water, and receive their last finish with powder of rotten stone. The process used for making ivory combs is nearly the same as that already described, except that the ivory is first sawed into thin slices. The best ivory comes from the island of Ceylon, and Achen, in the East Indies; as it possesses the property of never turning yellow, it is consequently much dearer than any other kind.

Tortoise-shell combs are much esteemed; and there are methods of staining horn, so as to imitate it, of which the following is one: the horn to be dyed is first to be pressed into a flat form, and then done over with a paste, made of two parts of quick-lime and one of litharge, brought into a proper consistence with soap-ley. This paste must be put over all the parts of the horn, except such as are proper to be left transparent, to give it a nearer resemblance to tortoise-shell. The horn must remain in this state till the paste be quite dry, when it is to be brushed off. It requires taste and judgment so to dispose the paste, as to form a variety of transparent parts, of different magnitudes and figures, to look like nature. Some parts should also be semi-transparent, which may be effected by mixing whiting with a part of the paste. By this means spots of a reddish brown will be produced, so as greatly to increase the beauty of the work. Horn thus dyed is manufactured into combs, and these are frequently sold for real tortoise-shell.

COMBAT, in law, or single combat, denotes a formal trial between two champions of some doubtful cause or quarrel, by the sword or batoons. This form of proceeding was anciently very frequent, particularly among the barbarous nations in their original settlements; and obtained, not only in criminal, but also in civil causes; being built on a presumption, that God would never grant the victory but to him who had the best right. It was originally permitted in order to determine points respecting the reputation of individuals, but afterwards became much more extensive. The accuser first swore to the truth of his accusation; the accused gave him the lie: upon which each threw down a gage, or pledge of battle, and the parties were committed prisoners to the day of combat. See CHAMPION.

COMBINATION, in mathematics, is the variation or alteration of any number of quantities, letters, sounds, or the like, in all the different manners possible. It is shewn, in the Memoirs of the French Academy, that two square pieces, each divided diagonally into two colours, may be combined 64 different ways, so as to form so many different kinds of chequer-work;

which appears surprizing enough, when one considers that two letters or figures can only be combined twice. See CHANGES.

COMBINATION, *doctrine of.* Prob. 1. Any number of quantities being given, together with the number in each combination, to find the number of combinations. One quantity admits of no combination; two, a and b, only of one combination; of three quantities, $a\,b\,c$, there are three combinations, *viz.* $a\,b$, $a\,c$, $b\,c$; of four quantities, there are six combinations, *viz.* $a\,b$, $a\,c$, $a\,d$, $b\,c$, $b\,d$, $c\,d$; of five quantities, there are ten combinations, *viz.* $a\,b$, $a\,c$, $b\,c$, $a\,d$, $b\,d$, $c\,d$, $a\,e$, $b\,e$, $c\,e$, $d\,e$. Hence it appears that the numbers of combinations proceed as 1, 3, 6, 10; that is, they are triangular numbers whose sides differ by unity from the number of given quantities. If this then be supposed q, the side of the number of combinations will be $q-1$, and so the number of combinations $\frac{q-1}{1}, \frac{q+0}{2}$. See TRIANGULAR NUMBERS.

If three quantities are to be combined, and the number in each combination be three, there will be only one combination, $a\,b\,c$; if a fourth be added, four combinations will be found, $a\,b\,c$, $a\,b\,d$, $b\,c\,d$, $a\,c\,d$; if a fifth be added, the combinations will be ten, *viz.* $a\,b\,c$, $a\,b\,d$, $b\,c\,d$, $a\,c\,d$, $a\,b\,e$, $b\,d\,e$, $b\,c\,e$, $a\,c\,e$, $a\,d\,e$; if a sixth, the combinations will be twenty, &c. The numbers, therefore, of combinations proceed as 1, 4, 10, 20, &c. that is, they are the first pyramidal triangular numbers, whose side differs by two units from the number of given quantities. Hence if the number of given quantities be q, the side will be $q-2$, and so the number of combinations $\frac{q-2}{1}, \frac{q-1}{2}, \frac{q+0}{3}$.

If four quantities are to be combined, we shall find the numbers of combinations to proceed as pyramidal triangular numbers of the second order, 1, 5, 15, 35, &c. whose side differs from the number of quantities by the exponent minus an unit. Wherefore if the number of quantities be q, the side will be $q-3$, and the number of combinations $\frac{q-3}{1}, \frac{q-2}{2}, \frac{q-1}{3}, \frac{q+0}{4}$. See PYRAMIDAL NUMBERS.

Hence is easily deduced a general rule of determining the number of combinations in any case whatsoever. Suppose, for example, the number of quantities to be combined q, and the exponent of combination n; the number of combinations will be $\frac{q-n+1}{1}, \frac{q-n+2}{2}, \frac{q-n+3}{3}, \frac{q-n+4}{4}$, &c. till the number to be added be equal to n. Take $q=6$ and $n=4$, the number of combinations will be $\frac{6-4+1}{1}\ \frac{6-4+2}{2}\ \frac{6-4+3}{3}\ \frac{6-4+4}{4} = \frac{6-3}{1}\ \frac{6-2}{2}\ \frac{6-1}{3}\ \frac{6+0}{4} = \frac{3}{1}\ \frac{4}{2}\ \frac{5}{3}\ \frac{6}{4} = 15$.

If it be required to know all the possible combinations of the given quantities, beginning with the combinations of the several two's, then proceeding to three's, &c. we must add $\frac{q-1}{1}\ \frac{q+0}{2}$, $\frac{q-2}{1}\ \frac{q-1}{2}\ \frac{q+0}{3}$, $\frac{q-3}{1}\ \frac{q-2}{2}\ \frac{q-1}{3}\ \frac{q+0}{4}$, &c.

Whence the number of all the possible combinations will be $\frac{q}{1}\ \frac{q-1}{2} + \frac{q}{1}\ \frac{q-1}{2}\ \frac{q-2}{3} + \frac{q}{1}\ \frac{q-1}{2}\ \frac{q-2}{3}\ \frac{q-3}{4} + \frac{q}{1}\ \frac{q-1}{2}\ \frac{q-2}{3}\ \frac{q-3}{4}\ \frac{q-4}{5}$ which is the sum of the unciæ of the binomial raised to the power q, and abridged of the exponent of the power increased by unity $q+1$. Wherefore since these unciæ come out $1+1$ by being raised to the power q; and since $1+1$ is equal to 2, $2^q - q - 1$ will be the number of all the possible combinations. For example, if the number of quantities be 5, the number of possible combinations will be $2^5 - 6 = 32 - 6 = 26$.

Prob. 2. Any number of quantities being given to find the number of all the changes which these quantities, combined in all the manners possible, can undergo. Let there be two quantities a and b, their variations will be two; consequently, as each of them may be combined with itself, to these there must be added two variations more. Therefore the number of the whole will be $2+2=4$. If there were three quantities, and the exponent of the variation 2, the combinations will be 3, and the changes 3; to wit, $a\,b$, $a\,c$, $b\,c$, and $b\,a$, $c\,a$, $c\,b$; to which if we add the three combinations of each quantity with itself $a\,a$, $b\,b$, $c\,c$, we shall have the number of changes $3+3+3=9$.

In like manner, it is evident, if the given quantities were 4, and the exponent 2, that the number of combinations will be 6, and the number of changes likewise 6, and the

number of combinations of each quantity with itself 4; and therefore the number of changes 16; if with the same exponent the given quantities were 5, the number of changes would be 25; and in general, if the number of the quantities were n, the number of changes would be n^2.

Suppose the quantities 3, and the exponent of variation 3, the number of changes is found $27 = 3^3$, *viz.* *aaa*, *aab*, *aba*, *baa*, *aac*, *aca*, *caa*, *abb*, *bab*, *bba*, *abc*, *bac*, *bca*, *acb*, *cab*, *cba*, *acc*, *cac*, *cca*, *bbb*, *bbc*, *cbb*, *bcb*, *bcc*, *cbc*, *ccb*, *ccc*. In like manner it will appear, if the quantities were 4, and the exponent 3, that the number of changes would be $64 = 4^3$; and in general, if the number of quantities was $= n$, and the exponent 3, the number of changes would be n^3.

By proceeding in this manner it will be found, if the number of quantities be n, and the exponent n, that the number of changes would be n^n. Wherefore, if all the antecedents be added, where the exponent is less, the number of all the possible changes will be found $n^n + n^{n-1} + n^{n-2} + n^{n-3} + n^{n-4}$, &c. till the number subtracted from n leaves 1, because the beginning is from single quantities taken once.

Since, then, the number of all possible changes is in a geometrical progression, the first or smallest term of which is n^1, the largest n^n, and the denominator n; it will be equal $(n^{n+1} - n) \div (n - 1)$. Suppose $n = 4$, the number of all possible variations will be $(4^5 - 4) \div (1 - 4) = \frac{1020}{3} = 340$.

Suppose again $n = 24$, the number of all the possible variations will be $(24^{25} - 24) \div (24 - 1) = 3200965864440681898677 955348250600$ divided by $23 = 139172428 888725299942512849340 2200$. In so many various methods may the 24 letters of the alphabet be varied and combined among themselves.

Combination, in chemistry, is the intimate union of two bodies, by chemical attraction, into one substance, so that neither of them can be recognized, nor can they be separated from each other by any mechanical force. Of this principle are the following instances. Salt will unite with water, from which it cannot be separated again but by chemical agency. Sulphur and lime may by heat be united and form a compound, the properties of which are totally dissimilar to those of either the substances used. In both cases an affinity has been exerted between the substances, and they have combined. Combination is to be distinguished from mixture, in which dissimilar particles are blended together, without being united by attraction, in which no new qualities are acquired, in which the difference of parts is easily discovered, and these parts are capable of being separated by mechanical means. It is distinguished from aggregation, which is merely the union of particles of the same kind of matter, forming an aggregate, uniform in composition, but possessing all the properties of the particles of which it is composed.

Combination, in military science. One ought to regard combination as forming a part of military science. A general who has an enterprize in contemplation, should, before he risks the execution of it, combine well in his mind all the ideas that can lead to its success; and he ought not always to rely on his own solution of the case. But when his ideas on the subject are pretty well fixed, he should lay them before the general officers, who are under his orders or command, for their opinion and concurrence.

Combinations, in law. Combinations to do unlawful acts, are punishable before the unlawful acts are executed; this is to prevent the consequences of combination and conspiracies, &c.

COMBRETUM, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four or five-toothed, bell-shaped, superior; corolla four or five-petalled, inserted into the calyx; stamina very long; seed one, four or five-angled, the angles membranaceous. There are four species. This genus is very imperfectly known, and being a very fine one, deserves the attention of the cultivators of exotic plants.

COMBUSTION. The temperature of bodies may be raised by various means, which are generally such as produce an agitation among the particles. The sun's light, and also the chemical or mechanical actions of bodies upon each other, if sufficiently intense or rapid, produce this effect. One of the most generally known methods of producing a high temperature consists in striking or rubbing bodies together; and there is no action more familiar to us, for this purpose, than the striking of a flint against a piece of steel. Whenever an elevated temperature is thus produced in a body communicating with the open air, it

is observable that, according to the nature of the body itself, the heat is either conducted away, and nothing farther happens, or else it continues and even increases so as to spread by communication through every part of the body, and produce a change in its nature. Thus, if one corner or extremity of a thin piece of stone or glass be made red hot, it will soon become cold again, and no farther effect will follow; but if the corner of a piece of paper or wood be heated in like manner, it will not, in common circumstances, become cold again without alteration, but the heat will be communicated to the whole mass, and will continue until the body shall have undergone a remarkable change. This phenomenon is called combustion or burning; the bodies which are liable to it are called combustible; and after they have undergone this process they are said to have been burned.

There are scarcely any chemical changes by which heat is produced, sufficient to exhibit the appearance of light, unless oxygen be in the act of entering into combination with a combustible body. One of the earliest observations respecting ordinary combustion must have been, that it cannot take place without common air, and that it is extinguished by shutting out the air. It is now well known, that the air acts only by means of its oxygen, which unites with and changes the combustible body.

The earlier doctrines respecting heat and fire are scarcely entitled to notice; and certainly must not occupy our pages. It will be sufficient for us to remark that the hypothesis of an element called fire, which was supposed to escape from burning bodies and ascend to a sphere above, was modified by Beccher and Stahl, by the supposition of a general principle, assumed to exist in all combustible bodies, and denominated phlogiston; capable of passing in combination from one body to another, or of flying off with a violent agitation, in which the heat was imagined to consist. As this theory was established upon the observation of a number of striking chemical facts, it was for a long time universally received. Various modifications were, however, proposed by different chemists, as discoveries came to be made; particularly with regard to the agency and combination of air in bodies, and afterwards those of the existence of oxygen, and the laws by which heat, or the cause of temperature, is governed. These advances led to the rejection of phlogiston altogether; a change of theory, which was more rapidly effected by the patronage, exertions, and scientific labours of Lavoisier; who devoted the influence of an elevated situation, the extent of his fortune, and the powers of an uncommonly clear and comprehensive intellect, to this object. It is to be regretted that, with claims so well founded and so great, this philosopher should have sought for more; but it is certainly true that he himself gave support to the powerful cry of that party which has proclaimed him the author of the modern theory of combustion; whereas if they had continued to do justice to Rey, Hooke, Mayow, Hales, Bayen, Priestley, and others, there would have been little of absolute facts left for Lavoisier to claim in the way of original discovery; though it would be difficult to find adequate terms to express the obligation under which the scientific world is placed with regard to him, for his ample and accurate repetition of experimental investigations, and the very luminous and able manner in which he has digested and stated the whole mass of facts, and applied them to theoretical results.

Combustion, as understood by modern chemists, is the rapid combination of oxygen with a body, which is attended with increase of temperature and the emission of light. The burned body is therefore an oxygenated compound. Thus we may form a notion of combustion by burning a piece of iron wire. If the diameter of the wire be very small, such, for example, as half the thickness of a hair, and it be made up into a tuft like wool, it may be lighted by a candle, and will burn like other more readily combustible bodies until it has received a certain portion of oxygen, after which the combustion will cease. If the same iron had been exposed to the atmosphere without additional heat, it would also have attracted oxygen, but in a longer time; and though the result might have been the same, we should not have called this slow process by the name of combustion.

Though the modern theory of combustion is simplified by rejecting phlogiston, and rendered more accurate by comprehending facts formerly unknown, yet it must not be disguised, that it is inadequate to account for the great and most striking fact, namely, the increase of temperature, otherwise than by hypothesis. Heat, or elevation of temperature, seems in the opinions of all philosophers to consist in the agitation of the particles of some thing, whether we suppose that thing to be the body itself, or a pecu-

liar element called caloric. According to those philosophers who assert the existence of this last principle, the combination of oxygen and the combustible body does emit or give out caloric, either because there is less room for it in the new compound, of which the capacity is changed, according to Dr. Irvine's doctrine; or because a portion of caloric, which was before latent or combined in one or both of the component parts, is, according to Black, given out in consequence of the resulting attraction of the new compound for it being less than before. They who are disposed to see this subject treated at length, may consult the system of the ingenious Fourcroy, where they will find the modern caloric affording the same general services to chemical hypothesis as were formerly obtained from its predecessor phlogiston.

Notwithstanding the truly valuable and numerous discoveries of facts by Black, Irvine, Crawford, and other modern philosophers, we are far from being in possession of proof that elevation of temperature is universally occasioned by diminution of capacity, or the extrication of latent heat. But, as we are upon the whole more habituated to consider bodies themselves, than their properties in the abstract, a preference has been given to the method, of ascribing events to peculiar additional substances, rather than to motions or modifications of the bodies in which they may take place. Many eminent philosophers have, nevertheless, considered heat as a motion in the particles themselves; but it is not so easy to speculate upon the principles of motion among a system of particles, as it is to assert the combination and disengagement of a chemical element, though this assertion does not remove the difficulty, but only places it a step farther off.

If we admit that the particles of a body do not touch each other; as appears to be established from the different degrees of inertia and of weight, as well as from the expansions and contractions occasioned by change of temperature, and other causes; and if we likewise consider the particles as attracting each other,—it appears to follow, by analogy from what we know of the rest of the universe, that they must be kept asunder by motion. From this inference we shall be led to consider natural masses as distinct systems of revolving particles; comparable with those nebulæ which occupy the celestial spaces, and of which the parts are, no doubt, governed by cometary and planetary revolutions. It is much to be regretted, that the mathematical consideration of this subject by Mr. Buée, in a work announced in Nicholson's Journal, vol. iii. p. 234, quarto series, has not yet been laid before the public.

The ordinary appearances of bodies in a state of combustion may be explained in a general way by attending to the state of the bodies which undergo it. If the parts of an ignited body, such as that of a piece of charcoal, become oxygenated, previous to, or at, the very instant of their separation from the mass, there will be no appearance of light but at the surface of the burning body; but if small parts of the body be separated from the general mass, during the very process of combustion, and before it is completed, as happens mechanically when the particles of iron are torn off by the action of a dry grindstone, or chemically when the particles of fat rise in vapour from the wick of a lighted candle, a burning mass will be seen, variable in its figure, which, in the latter case, is called flame. And that this explanation accounts for the flame of burning bodies, is manifested from the little difference between the two phenomena here mentioned, and the still less difference between the results, namely flame, which are produced by projecting the dust of rosin, or a stream of hydrogen, through the flame of a candle.

According to the theory which supposes caloric to be an independent substance, combustion must be a rapid union of oxygen with a combustible body; and the heat has been supposed to be given out from the oxygen during a condensation of this last, which, it is imagined, takes place universally in this process. This, however, has not been proved.

Dr. Thomson, considering caloric and light as distinct substances, has adduced many facts and observations to prove that as caloric abounds in oxygen, so light is a component part of every combustible. And thence, according to his doctrine, while the base of oxygen combines with the base of the combustible, the caloric of the one and the light of the other unite in the form of fire. From this theory he shows, why in the transitions of oxygen from one combustible base to another, the act of combustion does not take place; namely, because the caloric of the oxygen has no light presented to it to combine with. The whole doctrine, though undoubtedly requiring further developement and proof, is

intitled to the greatest attention of chemists. See Caloric, Capacity, Chemistry, Heat.

Combustion *of living individuals of the human species.* Citizen Lair, in 1797, communicated to the Philomathic Society at Paris a memoir on the spontaneous combustion of human individuals, of which instances are related in the Copenhagen Acts for 1692; the Annual Register, 1763 and 1775; the Philosophical Transactions, 1744; the Observations of Le Cat, 1729 and 1749; and the Journal de Medicine for 1779 and 1783: and to these he has added some others related by persons living at Caen, and on the testimony of a surgeon of the same town, who attested the circumstances of an event of this description by a verbal process.

Difficulties would no doubt be offered from reasoning against these facts; but the writer remarks, that human testimony is not to be rejected, unless the probability that the facts must be impossible shall be greater than that arising from the concurrence of evidence: and he adds, that the narratives, though varying so widely as to time and place, do very remarkably agree in their tenor. The circumstances are, that (1.) the combustion has usually destroyed the person by reducing the body to a mass of pulverulent fatty matter, resembling ashes. 2. There were no signs of combustion in surrounding bodies by which it could be occasioned, as these were little if at all injured; though (3.) the combustion did not seem to be so perfectly spontaneous, but that some slight cause, such as the fire of a pipe, or a taper, or a candle, seems to have began it. 4. The persons were generally much addicted to the use of spiritous liquors, were very fat; in most instances women; and old. 5. The extremities, such as the legs, hands, or cranium, escaped the fire. 6. Water, instead of extinguishing the fire, gave it more activity, as happens when fat is burned. 7. The residue was oily and fetid ashes, with a greasy soot, of a very penetrating and disagreeable smell.

The theory of the author may be considered as hypothetical, until maturer observations shall throw more light on the subject. The principal fact is, that charcoal and oil, or fat, are known in some instances to take fire spontaneously, and he supposes the carbon of the alcohol to be deposited in the fat parts of the human system, and to produce this effect.

COMEDY, a dramatic poem, representing some event in common life, which is supposed to take place among private individuals. Its object is to ridicule the vices and follies of mankind.

The unities of action, time and place, the division of the acts, the introduction of episodes, the intertexture of the scenes are common to both tragedy and comedy. But in other essentials they differ: the one inspires terror and pity; the other excites gaiety and mirth. The characters in tragedy are, kings, princes, tyrants, heroes; those in comedy are ridiculous people of quality, cits, valets, gossips, &c. The style also of the latter has its peculiar characteristics; it should be simple, lively, familiar, and replete with sallies of wit, satire, and genuine humour.

As almost all the rules of dramatic poetry are constructed with a view to strengthen the resemblance of fiction to reality, they ought in comedy to be most minutely attended to; because, as the scenes it represents bear a nearer affinity to real life, any defect in the resemblance is more readily discovered. Hence the necessity of truth in the delineation of character, of simplicity in the texture of the intrigue, of spirit and consistency in the dialogue, and of genuine nature in the sentiments. Hence, too, that grand requisite, the art of concealing art, in managing the progressive intricacy of the plot, which constitutes the illusion of theatrical representations. The intrigue of comedy does not consist in the construction of a fable barely probable, but in a natural series of familiar events, developed in the most clear and impressive way. It may be of use, therefore, to trace the rise and progress of comedy, with its various revolutions, in order to examine the principles on which those rules are founded, and to point out their various applications.

On the waggon of Thespis, comedy was a mere tissue of ribaldry, uttered to the passing multitude by vintagers with their faces stained with wine-lees. After the example of the Sicilian poets Epicharmus and Phormis, Crates gave it a more regular form, and raised it to a more appropriate stage. Comedy then took for its model the tragedy invented by Æschylus, or rather both were founded on the poems of Homer. This epoch is, properly speaking, the origin of comedy among the Greeks; they divided it into the old, the middle, and the new. The Athenian comedians

at first produced satires in action; that is to say, they represented characters known and named, whose follies and vices they imitated. This was the old comedy.

To repress this licence, the laws forbad the mention of names. Neither the malignity of the poets, however, nor that of the spectators lost any thing by this interdict. The resemblance of masks, dress, and gesture, designated public characters so well, that they were recognized at sight. Thus, in the middle comedy, the poet having no longer to dread the reproach of personality, was emboldened in his satirical attacks; at the same time he was doubly sure of applause, for while feeding the malice of his audience by the blackness of his portraits, he afforded their vanity the gratification of guessing his originals. It was in these two species that Aristophanes so often triumphed to the shame of the Athenians.

Satirical comedy presented at first view many appearances of advantage. There are vices against which the institutions of a state provide no punishment. Self interestedness, or incapacity, in the administration of public affairs, ingratitude, infidelity, breach of promise, the tacit and artful usurpation of the merit of another—all these escape the severity of law. Satirical comedy assigned to them a punishment the more terrible as it was inflicted in a public theatre. There the guilty were arraigned and the people sat in judgment. It was doubtless to maintain so salutary a species of terror, that the first satirical poets were not only tolerated, but even hired by the magistracy as censors of the republic. Even Plato was led away by this apparent advantage when he admitted Aristophanes into his banquet; if, indeed, the Athenian satirist, and the Aristophanes of the banquet are one and the same person, which may at least be fairly doubted.

Such was the state of comedy at Athens when her two great tragic poets acquired the glory of rendering virtue interesting, and crime odious, by the most affecting and terrible pictures. How singular that the same people should delight in exhibitions so opposite and contrasted! the heroes of Sophocles and Euripides were no more, but the sage calumniated by Aristophanes was still living. The Athenians could applaud with enthusiasm the great men of former days, while at the same time they could behold with satisfaction their wisest philosopher exposed to contempt and ridicule.

The government, too late, perceived that the poets had eluded, in what was called middle comedy, the law which forbad the mention of names; they enacted another which banished from the stage all personal imitation, and restricted comedy to the general representation of manners. This was the æra of new comedy: it ceased to be a direct satire, and assumed the legitimate and classical form which it has since preserved. Menander shone in this department, a poet as elegant and natural as Aristophanes was the reverse. We cannot but deeply regret the loss of his works, when we read the eulogies which Plutarch, in common with all the ancients, has pronounced on them.

But it is easier to copy what is gross and low, than what is refined and noble; hence the first Latin poets chose Aristophanes for their model. Of this number was Plautus, who, notwithstanding, does not resemble him. Terence, who came after Plautus, imitated Menander without equalling him; Cæsar used to call him a demi-Menander, and reproached him with his want of the *vis comica*, by which is meant those master-strokes which fathom character; which dive into the inmost recesses of the soul, and expose its hidden vices to public derision and shame.

Plautus excels in gaiety, strength, and variety: Terence in truth, delicacy, and elegance; the one has the advantage of imagination unrestrained by the rules of art over talents subjected to all those rules; the other has the merit of uniting sprightliness with decency, politeness with pleasantry, and exactness with ease; the one amuses by the matter, the other by the style, and we wish Plautus had the refinement of Terence, and Terence the humour of Plautus.

The modifications of comedy in its first stages, and the varieties observable in it at the present day, all originate in the predominating character of each particular people, and in their respective forms of government. Thus, in a democratical state, the administration of government, and the conduct of the leading men, being the chief objects of animadversion and censure, the Athenian people, ever discontented and restless, delighted in theatrical satires, which exposed not only the vices of individuals, but the concerns of government, the prevarications of orators, the faults of generals, and even their own facility to be duped and corrupted. Hence their ap-

plause at the political satires of Aristophanes. This licence was repressed as the government grew less popular, as may be seen in the later comedies of that author, and in what vestige remains of those of Menander. In these the state was always respected, and private intrigues were substituted for public cabals.

The Romans under the consuls, as jealous of liberty as the Athenians, but more jealous of the dignity of their government, never suffered the republic to be exposed to the shafts of poetic ridicule; hence their first comic authors ventured upon personal, but never upon political satire.

The low popular comedy was always freely tolerated, and the comedy of Grecian manners, called Palliata, enjoyed equal indulgence; but when the nobles of Rome were introduced on the stage, as in the pieces called Prætextæ and Togatæ, the action was more restrained, and ridicule was banished. This style, as Seneca observes, holds a middle rank between comedy and tragedy. But as luxury gradually softened the manners of Rome, comedy lost its keenness and severity, and the Romans having imbibed the vices of the Greeks, Terence to pourtray them had only to copy Menander.

The same influence of public taste and political institutions has determined the character of comedy in every nation in Europe, since the revival of letters. A nation which once affected a proud solemnity of manners, and a romantic pride of sentiment formed the model of its drama or intrigues full of incident, and on characters replete with hyperbole. Such is the Spanish theatre; their dramatic authors display a forced exaggeration, and a freedom of imagination which violates all rules. Yet with these faults, added to a fondness for puerile conceits, and far fetched equivoques, Lope de Vega has attained to the first rank among modern poets. He unites the happiest discrimination of character to a strength of invention, which even Corneille could admire. He took from Lope the character of his Menteur, and he declares he would have given two of his best pieces to have imagined it.

The Italian comedy is strongly indicative of the disposition of the people. Points of honour, amours, revenge for falsehood in affairs of gallantry, furnish abundance of perilous intrigues for lovers, and of endless play for the coquetries of valets and waiting women. The rage for pantomime and caricatura is conspicuous in all the comedies of the Italians, and they indulge it at the expense of their better judgment. Their plots are devoid of ingenuity, sense, and wit. There is hardly one among the immense collections of their pieces, which a man of taste would bear to read to the end. Indeed the Italians at last began to be sensible of this, and Florence set the example of substituting for these miserable farces the best comedies of Moliere translated into Italian. Other states followed the example, and in all probability the French comedy will soon become general in Italy.

A nation, formerly counted the first in politeness and refinement, when every individual made it a duty to conform his sentiments and ideas to the manners of society, when prejudices were principles, and usages laws; this nation could afford few originals, its characters were softened by deference, and its vices palliated by good-breeding. The French comedy has, however, served to improve the English stage, as much as the difference of manners would allow. Moliere is certainly a just model of comic excellence; he possesses that philosophic penetration which seizes extremes as well as their intermediate degrees, and that power of contrast which gives force to his painting, which the delicacy of his pencil might otherwise have lost.

In a country like ours, where every individual glories in his privilege of thinking for himself, originals must always abound. Hence the English comedy excels all others in strength of character, and in the true expression of nature: it is simple, consistent, and philosophical. The genius of Shakspeare has been considered by some as most happy in comedy; the truth is, that in every department of the drama he is supreme. Clouds and mists may at times obscure him, but he is still the sun of the poetic hemisphere, and all other luminaries before his splendour must dwindle to the magnitude of stars.

The plays of his contemporary, Jonson, though antiquated and obsolete, contain sallies of the finest satire, and strokes of genuine comic humour. Those of Fletcher and Massinger, and of other poets of that age, had the merit of contributing to the advancement of our drama, and laid the foundation of its present excellence.

After a dark period of puritanical fanaticism, the English comedy revived in the

reign of Charles II.; but the stage was but too faithful a mirror of his licentious court. The comedies of Dryden are tinged with this alloy: indeed in other respects they add little honour to the name of that poet. Those of Otway are too obscene to be acted, or even read. The comic Muse of Congreve has been equally blamed for licentiousness and for exuberance of wit. The latter reproach may perhaps justly apply to the best comic productions of the present age.

Comedy has been divided into three kinds, according to the ends which it proposes. By pourtraying vice, it renders it contemptible, as tragedy renders crime odious: this is characteristic comedy. When men are represented as the sport of fortune it is called incidental comedy. When the domestic virtues are drawn in amiable colours, and in situations where misfortune renders them interesting, it may be termed sentimental comedy.

The first of these is the most useful to manners, and at the same time the strongest, the most difficult, and of course the rarest. It traces vice to its source; it attacks it in its principle; it presents the mirror to mankind, and makes them blush at their own image. Hence it supposes in its author a consummate knowledge of human nature, a prompt and accurate discernment, and a vigour of fancy which seizes at once what penetration could not comprehend in detail.

Incidental comedy is perhaps the most successful and popular, as it keeps the attention continually awake by lively and unexpected changes, and as it furnishes a source of amusement and mirth when the sallies of wit might fail in their effect by too frequent recurrence, if not relieved by such aid.

Sentimental comedy is perhaps more useful to morals than even tragedy, as it excites a deeper interest, because the examples it holds forth affect us more nearly. But as the style of comedy can neither be sustained by the grandeur of objects, nor animated by the strength of incident and situation, as it should be at the same time familiar and interesting, there are two different extremes to be avoided—of being cold and of being romantic. Simple nature is the true middle path, and it is the highest effort of art to be at the same time artful and natural.

A style of comedy superior to these is that which unites characteristic with incidental comedy. Here the characters are involved by the foibles of the mind and the vices of the heart in the most humiliating cross purposes, which expose them to the laughter and contempt of the audience. A happier specimen of this style could not be found than in the School for Scandal.

Such are the three kinds of comedy. There are others, which we have purposely omitted to enumerate. First, that obscene comedy, which is no longer suffered on the stage but by a sort of prescription, and which cannot excite a smile without raising a blush; secondly, that drama of false sentiment, the offspring of the German school, which once threatened to destroy our taste for genuine comedy, but which has now happily passed into oblivion; and, lastly, that comedy of low fun and pantomime trick, the feeble resource of minds without genius, talent, or taste, which it is the disgrace of the British stage of the present day to bring forward, and the reproach of the British public to tolerate and encourage.

COMET. See Astronomy.

COMETARIUM, a curious machine exhibiting an idea of the revolution of a comet about the sun. It is contrived in such a manner, as by elliptical wheels to shew the unequal motion of a comet in every part of its orbit. The comet is represented by a small brass ball, carried by a wire, in an elliptic groove about the sun in one of its foci, and the years of its period are shewn by an index moving with an equable motion over a graduated silver circle.

COMETES, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Tricoccæ. Essential character: involucre four-leaved, three-flowered; calyx four-leaved; capsule tricoccous. One species, *viz.* C. alterniflora, an annual, and a native of Suratte.

COMMA, among grammarians, a point or character marked thus (,), serving to denote a short stop, and to divide the members of a period.

COMMANDANT, in the army, is that person who has the command of a garrison, fort, castle, regiment, company, &c.

COMMANDER, in the navy, an officer who has the command of a ship of war under 20 guns, a sloop of war, armed ship, or bomb-vessel. He is entitled Master and Commander, and ranks with a Major of the army.

COMMANDER *in chief* is the chief admiral in any port, or on any station, appointed to hold the command over all other admirals within that jurisdiction.

COMMELINA, in botany, so called in honour of John and Casper Commelins, two famous Dutch botanists, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: corolla six-petalled; nectaries three, cross-shaped, pedicelled. There are twelve species, natives of warm climates.

COMMENDAM, in the ecclesiastical law, the trust or administration of the revenues of a benefice, given either to a layman to hold, by way of *depositum*, for six months, in order to repairs, &c. or to an ecclesiastic, or beneficed person, to perform the pastoral duties thereof, till once the benefice is provided with a regular incumbent.

Commendams were formerly a very laudable institution: for when an elective benefice became vacant, for which the ordinary could not, for some reason, immediately provide, the care of it was recommended to some man of merit, who took upon him the direction of it, till the vacancy was filled up, but enjoyed none of the profits.

At length it became a maxim among the canonists, that a clerk might hold two benefices, the one titular, and the other in commendam: yet still, the commendam was to continue only till other provisions were made; and afterwards they began to be given for a determinate time.

COMMENSURABLE, among geometricians, an appellation given to such quantities as are measured by one and the same common measure.

Commensurable *numbers*, whether integers or fractions, are such as can be measured or divided by some other number, without any remainder: such are 12 and 18, as being measured by 6 or 3.

COMMERCE, the exchange of the natural or artificial productions of a country, for those of another, either by barter or by representative signs of their value: the most general representative of the value of other commodities being coin or bullion, the profits of commerce are frequently estimated by the quantity of money it brings into a country; but a very beneficial foreign trade may be carried on without any balance being payable in money, or the balance may be absorbed by payments on other accounts. The commerce of Great Britain has long been in a very flourishing state, and has become of unparalleled extent, but the quantity of coin and bullion in the country has not increased in any considerable degree.

Commerce, in a general point of view, is usually distinguished into two kinds, the commerce of import and of export; but there is little reason for this distinction, for whatever a nation imports, it must have paid an equivalent for to the country of which it is purchased, and consequently the two branches are intimately dependant, and could not exist separately for any considerable period. The value obtained in foreign markets, for the goods or manufactures which a nation exports, repays the labour of procuring or manufacturing them, with a profit to the master manufacturer and to the exporting merchant; and this value being invested in foreign produce which on importation affords a further profit to the merchant, it is evident that the transaction while it supports individuals, makes a real addition to the wealth of the country, by the greater value of the returns imported beyond that of the goods exported. Commerce, therefore, while it is the means of procuring a mutual interchange of conveniencies between distant countries, and of extending knowledge and civilization over every part of the globe, contributes essentially to the strength and influence of the countries by which it is encouraged.

Superficial views on subjects of political economy have inclined princes and statesmen to the opinions, that wealth consisted principally in gold and silver, and that those metals could be brought into a country which had no mines only by the balance of trade, or by exporting to a greater value than it imported; commerce has therefore experienced public encouragement, and agreeable to the principles on which its value has been estimated, the principal regulations have consisted in restraints upon importation, and encouragements to exportation. The duties and restrictions imposed by one country, either with the view of encouraging its trade and manufactures, or for the purpose of rendering commerce a source of public revenue, have, however, only created similar returns from other states, and the commerce of Europe has become a complicated system of high duties, drawbacks, prohibitions, and bounties, attended with much unnecessary expense, and holding out continual temptations to fraud and evasion. The impolicy and injustice of many of the existing restraints has been shewn by Dr. Adam Smith and others, and the prevalence of just sentiments of the reciprocal advantages of freedom of trade will render future com-

mercial arrangements more liberal and beneficial.

Commercial intercourse was one of the earliest effects of the progress of civilization, but it was not till the gradual improvement of navigation had lessened the dangers of long voyages, that distant nations were enabled to exchange their surplus produce, and to enjoy the conveniencies and luxuries of foreign climes. The Egyptians, at a very early period, opened a trade with the western coast of the continent of India; but the Phenicians and the Carthaginians carried commerce to a much greater extent, the trading voyages of the latter extending not only to all the coasts of Spain and Gaul, but even to Britain. The commerce of the Greeks was confined to the ports of the Mediterranean, till the foundation of Alexandria, which soon acquired the greater part of the trade with India, and became for a time the first commercial city in the world. The extent of the Roman empire, and the spirit of its government, gave facility and security to commercial transactions, and rendered Rome the metropolis of the commercial world, till the fourth century, when the seat of empire was removed to Constantinople which was thus made the emporium of commerce. Here it continued to flourish, even when the devastations of the Goths and Vandals had annihilated commercial intercourse in almost every other part of Europe, and a considerable trade with India was kept up, although after the conquest of Egypt by the Arabians it could only be carried on by a very tedious and difficult channel of conveyance.

The inhabitants of Italy who fled to the islands of the Adriatic, and founded the city of Venice, were led by their situation to the pursuit of commerce, which they carried on with success, and in no very great length of time became almost the sole carriers of the East Indian merchandize brought to Alexandria, which their vessels distributed to all parts of Europe. The example of Venice led to the cultivation of commerce at Genoa, Florence, Pisa, and other cities of Italy, which for several centuries were the only places in Europe that carried on any considerable foreign trade. The insecurity of property during the unsettled state of Europe which succeeded the destruction of the western empire, caused an almost general suspension of commercial intercourse, till the time of Charlemagne, whose extensive empire facilitated correspondence between different parts of Europe which had before little connection, while the establishment of Christianity in Germany contributed to the increase of cities and towns in the north of Europe, and introduced an acquaintance with the productions of more southern climates.

The encouragement given to manufactures in Flanders, and their consequent improvement, drew the merchants of other countries to the fairs and markets established at Bruges, Courtray, and many other towns, which thus became of considerable importance, while a taste for the productions of the East was spreading through almost every part of Europe, acquired in Palestine during the crusades, and contributing very materially to the encouragement of foreign trade. The productions of India were however obtained at great risk and expense, till the improvement of navigation by the invention of the mariner's compass, and the subsequent discovery of a passage to India by the Cape of Good Hope. This was soon followed by the still more important discovery of the West Indies, and the continent of America, events which filled Europe with astonishment, and opened a vast field for speculative and commercial enterprize. Spain and Portugal attempted to monopolize the benefits of the discovery of America, but their injudicious policy has rendered them little more than the channels through which the profits of this trade have been conveyed to more industrious states.

The establishment of English colonies in North America, the improvement of manufactures in Flanders, Holland, France, and England, the encouragement of navigation, the institution of public banks, and the more general practice of insurance, favoured the extension of commerce, supplied it with new materials, and rendered it more secure. It has been protected in all the states of Europe, by numerous laws and edicts, it has been encouraged by bounties and privileges, and commercial treaties have been formed between different nations for removing impediments and facilitating a mutually beneficial intercourse. The commerce of Europe has thus expanded in a degree of which former times could have no idea, and, while it has multiplied the luxuries and refinements of society, it has contributed essentially to the advancement of naval power, and been rendered by most states a fruitful source of public revenue.

COMMERCE *of Great Britain.* The unmanufactured commodities exported by England for many centuries before the woollen manufacture had made any progress, were sufficient to procure the few foreign articles then in request, and also to bring a yearly balance of cash, by which some other branches of foreign trade were carried on to a small extent, and a beginning was made to the acquirement of commercial capital. The foreign trade of this country was however, in its infancy, almost wholly in the hands of foreigners, who settled in London, and a few other ports, for the purpose of carrying on commerce with their respective countries; many of these merchants were Jews, whose profits must have been very considerable to induce them to submit to the impositions to which they were frequently exposed. By degrees some of the inhabitants of London, and of the ports lying opposite to France and Flanders, began to build ships of their own, and to enter into competition with the alien merchants.

In the reign of Edward III. the exports of England consisted chiefly of wool, skins, hides, leather, butter, tin, and lead, of which wool was by far the most considerable, the quantity amounting to about 30,000 sacks of 26 stone each in a year. From a record in the Exchequer it appears, that in 1354 the exports of England amounted to 294,184*l.* 17*s.* 2*d.* the imports to 38,970*l.* 3*s.* 6*d.* money of that time. This is a great balance, considering that it arose almost wholly from the exportation of wool and other raw materials, but it is not very probable that the excess of the exports was usually so great as in this particular year. It was not till the middle of this century that the English began to extend their commercial voyages to the Baltic; nor till the middle of the subsequent century that they sailed to the Mediterranean.

The improvement of the woollen manufacture greatly increased the value of the exports, as France had not then engaged in this manufacture, and Holland had not carried it to any considerable extent; so that England enjoyed almost a monopoly of that manufacture, for the supply of the north and west parts of Europe, before the year 1640; Spain and Portugal being then almost entirely supplied from this country with light draperies, as well for their home consumption, as for that of their extensive colonies, from whence, in return, we then received sugar, tobacco, drugs, and other commodities with which we are now supplied by our own colonies. In 1672 the Parliament repealed the duties payable by aliens on the exportation of the native commodities and manufactures of England, putting them in this respect on a level with English subjects. This salutary principle was further extended in 1700, by removing the duties on every kind of woollen goods, and on all kinds of corn, grain, and meal exported. Many subsequent events, as the establishment of the credit of the Bank, the union with Scotland, the consolidation of the two East India Companies, and the rapid improvement of the North American colonies, contributed materially to the advancement of the commerce of Great Britain; and Mr. Erasmus Phillips, in his "State of the Nation in respect to her Commerce, &c." makes "the balance of England's trade, one year with another, to have been in our favour, on an average or medium, 2,881,357*l.* from 1702 to 1712." This appears to have been somewhat beyond the truth, but it is certain that foreign trade was then gradually increasing, and it was greatly promoted by an act passed in 1722, for extending the principle which had been adopted with respect to woollen goods, by permitting the exportation, duty free, of all merchandize, the produce of Great Britain, (except a few particular articles) and the importation, duty free, of the materials for dyeing, essential to several manufactures.

From this period, the encouragement given to the fisheries in different parts, the increased cultivation of the West India islands, and the immense acquisitions of territory in the East Indies, have combined with the increasing wealth and population of Great Britain, to extend its commercial transactions in all directions, and greatly to augment their former magnitude. The great increase of the national expenditure has caused most articles of foreign produce to be burthened with a variety of heavy duties, and subjected commerce to numerous restrictions and impediments, yet under these disadvantages, it has of late years increased in an unparalleled degree, and in the year ending 5th January, 1807, produced a net revenue to government from the duties of customs amounting to 7,774,049*l.* 4*s.* 9*d.* This large contribution from foreign trade evinces its present magnitude; but its total amount, as well as that of its several branches, will be more particularly shewn from the Custom-house ac-

counts of the value of the commodities exported and imported. These accounts being formed according to rates established in the year 1696, which in most instances are greatly below the present value of the articles, certainly give an inadequate idea of the magnitude of the commerce of Great Britain; but this very circumstance renders them in a comparative view the more indisputable evidence of its increase.

Total official Value of the Imports and Exports of Great Britain, in the Year 1805.

	Imports.	Exports.
Denmark and Norway	£1,071,579	£5,172,066
Russia	2,527,078	1,646,475
Sweden	269,161	159,597
Poland	429,450	80,500
Prussia	1,790,781	5,520,072
Germany	319,444	2,180,784
Holland	726,264	418,801
Flanders	3,070	23,343
France	469,820	551
Portugal and Madeira	936,500	1,495,814
Spain and Canaries	916,165	111,380
Streights and Gibraltar	42,919	183,823
Italy	393,517	507,535
Malta	9,304	127,514
Turkey	103,590	135,410
Ireland	3,010,609	3,758,973
Isle of Man	21,697	62,431
Guernsey, Jersey, &c.	81,241	198,324
Greenland	261,086	952
Total of Europe	13,383,275	21,784,345
America and West Indies	9,615,161	12,163,917
Asia	6,072,160	1,638,600
New Holland	153	30,643
Africa	105,976	980,789
Sierra Leone	867	10,660
Total	£29,177,592	£36,608,954

The commerce of Great Britain with the countries surrounding the Baltic has always been deemed of much importance, as being the principal means of procuring the stores necessary for the maintenance of its navy. The capital employed in this branch of trade must be much greater than formerly, from the increased price of hemp, iron, masts, and timber of all kinds, pitch, tar, and the other articles of import. The returns from this country are British manufactures of various kinds, East India goods, and West India produce.

The trade with Germany experienced a great augmentation about the year 1794, when it became the channel through which Holland, France, and other parts of the Continent obtained the goods which, in times of peace, they had usually imported direct from Great Britain. The port of Hamburgh for a time possessed the principal share of the trade of Europe, but the unusual flow of business in this direction encouraged a spirit of adventure and speculation, which in 1799 produced great embarrassment, involving not only the merchants of Hamburgh, but also some of the most considerable houses in Bremen, Frankfort, Amsterdam, and London. The trade with Germany, however, continued of great importance, till the influence of France obliged them to break off their intercourse with this country.

The trade with Holland and Flanders, one of the most ancient branches of the commerce of this country, has not increased in proportion with the trade to other parts: it is, however, still considerable in time of peace. The total value of the exports to Holland in 1792 was 1,516,449*l.*, in 1802 they amounted to 4,957,997*l.*

France enjoying great natural advantages,

and having for a long time many colonial possessions, had not occasion to receive much merchandize from this country. The frequent hostilities between the two countries has likewise prevented the formation of permanent commercial connections, but some intercourse of this kind always subsisted even in time of war, particularly with the ports of Calais, Bourdeaux, Havre, and Rouen, till the reign of Buonaparte, who resorted to a new mode of warfare, by prohibiting all intercourse whatever with Great Britain, even through the intervention of neutral vessels.

The commerce with Spain and Portugal has not of late years been of great extent; the export to the latter country however, consisting almost wholly of British produce and manufactures, has generally been considered a valuable branch of foreign trade, and measures have been frequently adopted for its preservation. In 1801, when Portugal was threatened with invasion, the wines of that country were allowed to be imported and warehoused, on bond being given for payment of the duty when taken out for consumption. The removal of the government to the Brazils, and subjugation of the country by the French, must cause a great revolution in this branch of trade.

The Mediterranean trade suffered great interruption from the war which began in 1793; and in the war of 1803, it was reduced to little more than the supply of the islands of Sicily and Malta.

The exports to the coast of Africa must experience a considerable diminution, from the abolition of the slave trade, till a more reputable species of traffic is cultivated with the inhabitants of that extensive continent, who will be induced to furnish a greater quantity of their native commodities, in order to procure the cheap manufactures and luxuries to which they have been accustomed.

The East India trade has always been deemed very lucrative, but from the risks of such a distant voyage, the necessity of a large capital, and other circumstances, most of the states of Europe have deemed it expedient to vest this trade in the hands of an exclusive company. From about the year 1750 the mercantile concerns of the English East India Company have become blended with the revenues derived from the territorial possessions which they have acquired in India, and which have been augmented to an immense extent, as the nett amount of these revenues, as well as the fortunes acquired by their officers and servants, are invested in merchandise, in order to be remitted to Great Britain. The imports of the Company have therefore increased very considerably, and in the year 1797, Mr. Irving, the inspector general of imports and exports, gave his opinion, that, including the private trade of individuals, carried on through the medium of the Company, and the proceeds of the territorial revenues, Great Britain derived an actual profit from the East India trade of about 2,300,000*l.* per annum. The principal articles imported from the East Indies are, from China, teas, nankeen cloths, and raw silk; from Bengal, piece goods of various kinds, raw silk, pepper, saltpetre, spices, drugs, sugar, coffee, &c. The total value of all the goods sold at the Company's sales, in the year ending 1st March, 1806, was 8,781,442*l.*

The West India trade, in the year 1787, employed about 130,000 tons of shipping; and in the year 1804, above 180,000 tons, navigated by 14,000 seamen. In 14 years, ending 1804, the value of the imports had increased nine millions sterling, and the revenue derived from them had increased about three and a half millions, including the conquered colonies; but exclusive of these, the imports from the West Indies were about a fourth of the whole imports of Great Britain. This branch of trade is however subject to great fluctuations, of which a remarkable instance has occurred since the year 1792. The destruction of St. Domingo, the most productive sugar colony in the world, gave a new aspect to British West Indian affairs. A yearly quantity of above 110,000 hogsheads being thus suddenly taken out of the market, the prices rose to an unusual height. The confusion which took place in Guadaloupe soon after, and the operations of the war in the West Indies, diminished the supply, and raised the price of produce still further. This of course became a great inducement to increase the cultivation of the British islands, and of those recently conquered, while about the same time, the introduction of the Bourbon cane enabled even the bad lands of the old islands to produce plentiful crops of sugar. From these causes the quantity of sugar has been constantly and rapidly increasing since 1792; the blank occasioned in that year has been filled up, and a great surplus has been added to the ordinary produce of former periods. The produce of the Spanish islands during the

same period has increased rapidly. These circumstances caused a sudden decline in the price of sugar, which became unusually low in 1807, and, combined with the interruption of the export trade to the continent of Europe, reduced the West India merchants and planters to great difficulties.

The American war was regarded by many persons as involving, in a great measure, the ruin of the foreign commerce of Great Britain. Since the establishment of the independence of the American States, however, experience has proved that we derive a much greater benefit from that country than heretofore, as we now take from them no more than it is our interest to take, while from having but little capital, and much employment at home, it must be many years before they can attempt to rival us in any considerable branch of foreign trade. The exports to America consist almost wholly of British manufactures, the official value of which in the year 1800 was 6,885,507*l.*; the imports are tobacco, rice, corn, and other unmanufactured produce. A very considerable trade is also carried on between the United States and the British West India islands, which is considered as almost essential to the support of the latter. The trade with the remaining British possessions in North America, is not of great extent; the principal branches of it are the fur trade of Canada, Hudson's Bay, and the Newfoundland fishery.

The total amount of the exports and imports sufficiently proves that the mercantile shipping of Great Britain must be greatly increased beyond what was employed in former periods. The total number of vessels that entered inwards and cleared out, with their tonnage, and the number of men and boys usually employed in navigating the same, as shewn in the following statement for three years ending the 5th January, 1807, will furnish a correct idea of the extent of shipping employed in the commerce of Great Britain.

	INWARDS.			OUTWARDS.		
	Ships.	Tons.	Men.	Ships.	Tons.	Men.
1804	14,779	2,002,686	113,723	15,224	2,051,135	124,255
1805	15,931	2,186,173	121,899	15,540	2,101,030	125,332
1806	15,911	2,095,568	120,342	15,710	2,054,472	124,189

By the act imposing a duty on all sea assurances, as well as by the act for establishing the convoy duty, the extent and value of the foreign trade of this country has been more clearly ascertained than heretofore, and it appears that the capital employed in commerce cannot be less than 80,000,000*l.* The annual profit derived from it has been variously estimated, but according to the best authority, it appeared in the year 1797 to be about 10,500,000*l.* per annum.

COMMERSONIA, in botany, so called in memory of M. Commerson, the French traveller, a genus of the Pentandria Pentagynia. Essential character: calyx one-leafed, bearing the corolla; petals five; nectary five-parted; capsule five-celled, echinate. One species, a native of Otaheite and the other Society Isles.

COMMISSARY, in the ecclesiastical law, an officer of the Bishop, who exercises spiritual jurisdiction in places of a diocese so far from the episcopal see, that the chancellor cannot call the people to the bishop's principal consistory court, without giving them too much inconveniency.

COMMISSARY *general of the musters*, an officer appointed to muster the army, as often as the general thinks proper, in order to know the strength of each regiment and company, to receive and inspect the muster-rolls, and to keep an exact state of the strength of the army.

COMMISSARY *general of stores*, an officer in the artillery, who has the charge of all the stores, for which he is accountable to the office of ordnance.

COMMISSARY *general of provisions*, an officer who has the inspection of the bread and provisions of the army.

COMMISSION, in common law, the warrant or letters-patent which all persons exercising jurisdiction have to empower them to hear or determine any cause or suit: as the commission of the judges, &c. Most of the great officers judicial and ministerial of the realm are made also by commission; by means of commission, oaths, cognizance of fines, answers in chancery, &c. are taken; witnesses examined, offices found, &c.

COMMISSION *of bankruptcy* is the commission that issues from the Lord Chancellor, on a person's becoming a bankrupt within any of the statutes, directed to certain commissioners appointed to examine into it, and

to secure the bankrupt's lands and effects, for the satisfaction of his creditors.

COMMISSIONERS, *Lords, of the Admiralty*, are five or seven persons appointed by the crown for executing the office of Lord High Admiral, to whose jurisdiction all maritime affairs are entrusted. See ADMIRALTY COURT.

COMMISSIONERS *of the Navy*, officers appointed to superintend the affairs of the marine, under the direction of the Lords of the Admiralty. Their duty is more immediately concerned in the building and repairing ships: they have also the appointment of certain officers.

COMMITMENT, in law, the sending of a person charged with some crime to prison, by warrant or order. A commitment may be made by the King and council, by the judges of the law, the justices of peace, or other magistrate, who have authority by the laws and statutes of the realm so to do. Every commitment should be made by warrant under the hand and seal of the party committing, and the cause of commitment is to be expressed in the warrant. The terms of it must also require the criminal to be kept in custody till discharged according to due course of law, &c. Wheresoever a constable or person may justify the arresting another for a felony, or treason, he may justify the sending him or bringing him to the common gaol. But it is most adviseable, for any private person who arrests another for felony, to cause him to be brought as soon as possible before some justice of peace, that he may be committed or bailed by him. The Privy-council, or any two of them, or a Secretary of State, may lawfully commit persons for treason, and for other offences against the state. All felons shall be committed to the common gaol, and not elsewhere. 5 Hen. IV. c. 10. But vagrants and other criminals, offenders, and persons charged with small offences, may, for such offences, or for want of sureties, be committed either to the common gaol or house of correction, as the justices in their judgment shall think proper. 6 G. c. 19. All persons who are apprehended for offences not bailable, and those who neglect to offer bail for offences which are bailable, must be committed; and wheresoever a justice of peace is empowered to bind a person over, or to cause him to do a certain thing, he may commit him, if in his presence he shall refuse to be so bound, or do such a thing. A commitment must be in writing, either in the name of the king, and only tested by the person who makes it; or it may be made by such person in his own name, expressing his office or authority, and must be directed to the gaoler or keeper of the prison. The commitment should contain the name and surname of the party committed, if known; if not known, it may be sufficient to describe the person by his age, &c. and to add, that he refuses to tell his name. It ought to contain the cause, as for treason or felony, or suspicion thereof; and also the special nature of the felony, briefly, as for felony, for the death of such an one, or for burglary, in breaking the house of such an one. All commitments grounded on acts of parliament ought to be conformable to the method prescribed by them. And where a statute appoints imprisonment, but does not limit the time, in such case the prisoner must remain at the discretion of the court. If the gaoler shall refuse to receive a felon, or take any thing for receiving him, he shall be punished for the same by the justices of gaol delivery. But no person can justify the detaining a prisoner in custody, out of the common gaol, unless there be some particular reason for so doing; as if the party should be so dangerously ill, that it would apparently hazard his life to send him to gaol, or that there be evident danger of a rescue from rebels, or the like. The sheriff or gaoler shall certify the commitment to the next gaol delivery.

COMMITMENT *discharged*. A person legally committed for a crime, certainly appearing to have been done by some person or other, cannot be lawfully discharged but by the king, till he be acquitted upon his trial, or have an *ignoramus* found by the grand jury, or none shall prosecute him, on a proclamation for that purpose by the justices of gaol delivery.

COMMITTEE *of Parliament*, a certain number of members appointed by the House for the examination of a bill, making report of an inquiry, process of the house, &c. When a Parliament is called, and the speaker and members have taken the oaths, there are committees appointed to sit on certain days, *viz.* the committee of privileges and elections, of religion, of trade, &c. which are standing committees. Sometimes the whole House resolves itself into a committee, on which occasion each person has a right to speak and reply as often as he pleases, which is not the case when a house is not in a committee.

COMMODORE, in maritime affairs, an

officer of the British navy, commissioned by the Lords of the Admiralty, or by an admiral, to command a squadron of men of war in chief; during which time he bears the rank of brigadier-general in the army, and is distinguished from the inferior ships of his squadron by a broad red flag, or pendant, tapering towards the outer end, and sometimes forked. The title Commodore is given by courtesy to the senior captain where three or more ships of war are cruizing in company. The word also is used to denote the convoy ship in a fleet of merchant-men; who carries a light in his top to conduct the rest, and keep them together.

COMMON, is a right of privilege which one or more persons claim to take or use, in some part or portion of that, which another man's lands, waters, woods, &c. naturally produce; without having an absolute property in such lands, woods, waters, &c.

Common *law*, that body of rules received as law in England, before any statute was enacted in parliament to alter the same.

The common law is grounded upon the general customs of the realm, including the law of nature, the law of God, and the principles and maxims of law; it is also founded on reason, as said to be the perfection of reason acquired by long study, observation, and experience, and refined by the learned in all ages. It may likewise be said to be the common birthright that the subject has for the safeguard and defence not only of his goods, lands, and revenues, but of his wife, children, life, fame, &c. Our common law, it is said, after the heptarchy, was collected together into a body by divers of our ancient kings, who commanded that it should be observed through the kingdom; and it was therefore called common law because it was common to the whole nation, and before only affected certain parts thereof, being anciently called the sole-right, that is, the right of the people.

The common law of England is, properly, the common customs of this kingdom; which, by length of time, have obtained the force of laws. The goodness of a custom depends upon its having been used time out of mind; or, in the solemnity of our legal phrase, time whereof the memory of man runneth not to the contrary. This gives it its weight and authority; and of this nature are the maxims and customs which compose the common law, or *lex non scripta*, of this kingdom. This unwritten, or common law, is properly distinguished into three kinds: 1. General customs, which are the universal rule of the whole kingdom, and form the common law in its stricter and more useful signification. 2. Particular customs, which for the most part affect only the inhabitants of particular districts. 3. Certain particular laws, which by custom are adopted and used by some particular courts of pretty general and extensive jurisdiction.

Common *place book*, among the learned, denotes a register of what things occur worthy to be noted in the course of a man's study, so disposed as, that among a number of subjects, any one may be easily found. Several persons have their several methods of ordering them; but that which is best recommended is Mr. Locke's method, which he has published in a letter to Mr. Toisnard, determined thereto by the great conveniency and advantage he had found from it in twenty years experience. The substance of this method is as follows:

The first page of the book, or, for more room, the two first pages fronting each other are to serve for a kind of index to the whole, and contain references to every place or matter therein; in the commodious contrivance of this, so as it may admit of a sufficient variety of materials, without confusion, all the secret of the method consists. The manner of it, as laid down by Mr. Locke, will be conceived from the following specimen, wherein what is to be done in the book for all the letters of the alphabet is here shewn in the first four.

A	*a*	
	e	
	i	
	o	
	u	
B	*a*	
	e	2. 3.
	i	
	o	
	u	
C	*a*	
	e	
	i	
	o	
	u	
D	*a*	
	e	
	i	
	o	
	u	

The index of the common place book be-

ing thus formed, it is ready for the taking down any thing therein.

In order to this, consider to what head the thing you would enter is most naturally referred, and under which one would be led to look for such a thing; in this head or word regard is to be had to the initial letter, and the first vowel that follows it; which are the characteristic letters whereon all the use of the index depends.

Suppose *e. g.* I would enter down a passage that refers to the head beauty; B, I consider, is the initial letter, and *e* the first vowel; then looking upon the index for the partition B, and therein the line *e* (which is the place for all words whose initial is B, and the first vowel *e;* as beauty, beneficence, bread, bleeding, blemishes, &c.) and finding no numbers already wrote to direct me to any page of the book where words of that characteristic have been entered, I turn forward to the first blank page I find, which in a fresh book, as this is supposed to be, will be page 2, and here write what I have occasion for on the head beauty; beginning the head in the margin, and indenting all the other subservient lines that the head may stand out and shew itself; this done, I enter the page where it is wrote, *viz.* 2, in the space B *e;* from which time the class B *e* becomes wholly in possession of the second and third pages, which are consigned to letters of this characteristic.

Note. If the head be a monosyllable beginning with a vowel, the vowel is at the same time both the initial letter and the characteristic vowel; thus the word Art is to be wrote in A *a*. Mr. Locke omits three letters of the alphabet in his index, *viz.* K, Y, and W, which are supplied by C, I, and U, equivalent to them: and as for Q, since it is always followed by an *u*, he puts it in the first place of Z; and so has no Z *u*, which is a characteristic that very rarely occurs. By thus making Q the last of the index its regularity is preserved without diminishing its extent. Others choose to retain the class Z *u*, and assign a place for Q *u* below the index.

If any imagine these hundred classes are not sufficient to comprehend all kinds of subjects without confusion, he may follow the same method and yet augment the number to 500, by taking in one more characteristic to them.

But the inventor assures us that in all his collections, for a long series of years, he never found any deficiency in the index as above laid down.

Common *Pleas* is one of the King's courts now held constantly in Westminster Hall, but in former times was moveable. All civil causes, as well real as personal, are, or were formerly, tried in this court, according to the strict law of the land. In personal and mixed actions it has a concurrent jurisdiction with the King's Bench, but has no cognizance of pleas of the crown. The actions belonging to the Court of Common Pleas come thither by original, as arrests and outlawries; or by privilege or attachment for or against privileged persons; or out of inferior courts, not of record, by pone, recordari, accedas ad curiam, writ of false judgment, &c. The chief judge of this Court is called Lord Chief Justice of the Common Pleas, who is assisted by three other judges: the other officers of the court are the custos brevium, who is the chief clerk; three prothonotaries and their secondaries; the clerk of the warrants, clerk of the essoins, fourteen filazers, four exigentors, a clerk of the juries, the chirographer, the clerk of the King's silver, clerk of the treasury, clerk of the seal, clerk of the outlawries, clerk of the inrolment of fines and recoveries, and clerk of the errors.

Common *prayer* is the liturgy in the Church of England. Clergymen are to use the public form of prayers prescribed by the Book of Common Prayer; and refusing to do so, or using any other public prayers, are punishable by 1 Eliz. c. ii.

Common, in grammar, denotes the gender of nouns, which are equally applicable to both sexes: thus parens, a parent, is of the common gender.

Common, in geometry, is applied to an angle, line, or the like, which belongs equally to two figures.

Common *divisor*, a quantity or number which exactly divides two or more other quantities or numbers, without leaving any remainder.

Common *measure*, is such a number as exactly measures two or more numbers without a remainder.

Common, *greatest, measure*, of two or more numbers, is the greatest number that can measure them; as 4 is the greatest common measure of 8 and 12.

COMMONS, in a general sense, consist of all such men of property in the kingdom, as have not seats in the House of Lords;

every one of whom has a voice in parliament, either personally, or by his representatives. In a free state, says judge Blackstone, every man, who is supposed a free agent, ought to be in some measure his own governor; and, therefore, a branch, at least, of the legislative power should reside in the whole body of the people. In so large a state as ours, it is therefore wisely contrived, that the people should do that by their representatives, which it is impracticable to perform in person; representatives chosen by a number of minute and separate districts, wherein all the voters are, or easily may be, distinguished.

COMMONS, in parliament, are the lower house, consisting of knights elected by the counties, and of citizens and burgesses by the cities and borough towns. In these elections, anciently, all the people had votes; but in the 8th and 10th of King Henry VI. for avoiding tumults, laws were enacted, that none should vote for knights but such as were freeholders, did reside in the county, and had forty shillings yearly revenue; equivalent to near *20l.* a year of our present money: the persons elected for counties to be *milites notabiles*, at least esquires, or gentlemen fit for knight-hood; native Englishmen, at least naturalized; and twenty-one years of age: no judge, sheriff, or ecclesiastical person, to sit in the House for county, city, or borough.

The House of Commons, in Fortescue's time, who wrote during the reign of Henry VI. consisted of upwards of 300 members: in Sir Edward Coke's time their number amounted to 493. At the time of the union with Scotland, in 1707, there were 513 members for England and Wales, to which 45 representatives for Scotland were added; so that the whole number of members amounted to 558. In consequence of the union with Ireland in 1801, 100 members were added for that country; and the whole House of Commons now consists of 658 members.

COMMONS, *Doctors.* See COLLEGE *of Civilians.*

COMMUNIBUS *locis*, a Latin term frequently used by philosophical writers, implying some medium or common relation between several places. Thus Dr. Keil supposes the ocean to be one quarter of a mile deep *communibus locis*, that is at a medium, or taking one place with another.

COMMUNIBUS *annis* has the same meaning with regard to time, that *communibus locis* has with regard to places.

COMMUNICATION *of motion*, the act whereby a body at rest is put into motion by a moving body; or, it is the acceleration of motion in a body already moving. See MECHANICS.

COMMUTATION, in law, the change of a penalty or punishment from a greater to a less; as when death is commuted for banishment, &c.

COMOCLADIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx three-parted; corolla three-parted; drupe oblong, with a two-lobed nucleus. There are three species, natives of the West Indies.

COMPANY, in commerce, an association formed for carrying on some branch of trade which requires a greater capital than private traders can usually command, or which is liable to engagements to which individual responsibility is deemed inadequate. In the infancy of commerce, almost every branch of foreign trade was carried on by a particular company, which generally possessed exclusive privileges; and such institutions were then necessary and beneficial; but in modern times, when individuals have accumulated larger capitals, and the improvement of navigation facilitated commercial intercourse with all parts of the world, and the general practice of insurance reduced the risk of foreign voyages to a regular addition to the cost of commodities, there are very few branches of foreign trade which cannot be more advantageously carried on by individuals, or private co-partnerships, than by public companies.

When companies do not trade upon a common stock, but are obliged to admit any person properly qualified upon paying a certain fine, and agreeing to submit to the regulations of the company, each member trading upon his own stock, and at his own risk, they are called regulated companies. When they trade upon a joint stock, each member sharing in the common profit or loss in proportion to his share in this stock, they are called joint stock companies. The regulated companies for foreign trade, which at present subsist in Great Britain, are the African Company, the Turkey, or Levant Company, the Russia Company, and the Eastland Company; they have, however, little more than a nominal existence, as any person may freely trade to these parts without being a member of any company, on paying a very small addi-

tional duty. The principal joint-stock companies for foreign trade, are the East India Company, and the Hudson's Bay Company; the South Sea Company has long given up its commercial undertakings, and the Sierra Leone Company has not yet acquired much importance. There is, however, a multitude of joint-stock companies established, some with exclusive privileges, but in general without any such advantage, for carrying on the banking business, for the different kinds of insurance, for granting and purchasing annuities, for making docks, navigable canals, tunnels, roads, or rail-ways, and for working mines.

The utility of joint-stock companies for many of these purposes, and the success which some of them have experienced, has frequently produced a disposition for the multiplication of such establishments, and an opinion that they might be extended to almost every branch of trade and manufactures. The rage for forming public companies was, in 1720, carried to a degree of infatuation, which led thousands to subscribe to projects the most useless or impracticable, and gave rise to such a spirit of speculation and stock-jobbing, as rendered necessary the interference of parliament. In consequence of the act then passed, 6 Geo. I. c. 18, upwards of two-hundred projected companies ended in the loss and disappointment of their respective subscribers. The recollection of this circumstance prevented for many years any similar attempts, till the frequency of subscriptions for making canals shewed the facility of raising large sums in this manner for any public undertakings, and led to the formation of joint-stock companies to other purposes. In the course of the year 1807, proposals were circulated for establishing six new insurance companies; seven subscription breweries; four public distilleries; five genuine wine companies; two vinegar manufactories; a corn, flour, and provision company; a united public dairy; a new medical laboratory for the sale of genuine medicines; three coal companies; a cloathing company; a linen company; a united woollen company; a paper company; two or three copper companies; a national light and heat company; two new banks; two commission sale companies; and a company for purchasing canal shares, and lending money for completing canals. On the Attorney General proceeding against one or two of these intended companies, most of the others were abandoned.

Company, *East India*, was established by a charter from Queen Elizabeth, dated 31st December, 1600, which, though not confirmed by act of parliament, was then considered as conferring an absolute exclusive privilege. Under this authority, the members of the Company traded for about twelve years, on their separate capitals, which, in 1613, they united into a joint-stock. In the reign of James I. the Company obtained a new charter, and enlarged their capital to 1,500,000; their profits at this time were not very great; and in the year 1655, Cromwell dissolved the Company and laid open the trade, but the mischief which followed obliged him to re-establish it about three years after. New charters were granted to the Company in 1661, 1669, and 1676, confirming all their former privileges, but as these privileges were derived merely from royal charters, without the sanction of parliament, their exclusive right began to be questioned, and individuals frequently endeavoured to participate in a commerce which had become very advantageous. These private adventurers increasing in number, the Company in 1683, found means to obtain another charter, by which all former charters were confirmed, and they were impowered to seize the ships and merchandize of individual traders, to maintain military forces, and to establish a court of judicature. They were soon after involved in war with the Mogul, and other embarrassments, which were attempted to be rectified by the oft tried expedient of a new charter, and being thus armed with new powers, they endeavoured to exclude effectually all individuals from interfering in the trade. In 1693, the charter of the Company became void, from default in payment of the tax imposed on their stock, but it was renewed upon condition of being determinable upon three years notice.

The company having sustained great losses during the war with France, and fallen into disrepute, a proposal was made in 1698, by Mr. Samuel Shepherd, and a number of other merchants, to advance for the public service 2,000,000*l.* at 8 per cent. interest, provided the sole exclusive trade to India was settled on them; the proposal was accepted, and a new company established by authority of parliament, and incorporated by charter under the title of the English Company trading to the East Indies. The contentions and emulation between the old and new Companies was so great,

that it became necessary, even for the sake of public tranquillity, to unite them: this was partly effected in 1702, and in 1708 the two Companies were, by act of parliament, perfectly consolidated under their present title of the United Company of Merchants of England trading to the East Indies. On the extension of the term of their exclusive trade to three years notice after Lady Day 1726, they lent to government the further sum of 1,200,000*l.* without receiving any additional interest, and as it was necessary to raise this sum by the sale of new stock, the capital of the company thus became 3,200,000*l.*

In 1712 the term of the company's exclusive trade was extended to three years notice after Lady Day 1733; which by a subsequent agreement was prolonged to 1766; and again, to three years notice after Lady Day 1780, with a provision, that if their exclusive privileges should be then determined, by the re-payment of all sums which they had lent to government, with all arrears of interest, the Company should still remain a corporation for ever, and enjoy the East India trade in common with all other subjects.

The interference of the Company, about the year 1750, in the contentions between some of the native princes, led to the acquirement of considerable territories, and laid the foundation of the extensive political authority which the Company now possess, and which comprehends dominions of greater extent than three times the area of the united kingdoms of Great Britain and Ireland.

On an average of 16 years preceding 1757, at which time the Company derived little assistance from territorial revenues, the annual sales of their imports amounted to about 2,055,000*l.*; and for the same period their exported goods and stores amounted annually at their prime cost, to 238,000*l.*; the bullion exported to 690,000*l.*; and they paid in discharge of bills of exchange 190,000*l.* During the succeeding ten years the sales of imports became increased to 2,150,000*l.* annually on the average, the quantity of bullion exported was reduced to about 120,000*l.* per annum, but the exports in goods and stores, and the money raised by bills of exchange were increased in a greater ratio compared with the returns from abroad. From 1767 to 1777 the export of goods was 490,000*l.*; in bullion about 110,000*l.*; the sums raised by bills 458,000*l.* per annum, and by the aid afforded from the revenues the investments were increased so as to produce about 3,300,000 per annum; the affairs of the Company during this period were however far from being in a flourishing situation; they were under the necessity of reducing their dividend, and of applying to parliament for assistance; but these difficulties being removed, the dividend, in 1778, was raised again to 8 per cent.

In the seven years ending with 1784, the average sales of the imports of the Company, notwithstanding the expensive war in which they were engaged, fell off in the proportion only of about 200,000*l.* annually; the export in bullion was for that period very trifling, but the goods and stores exported were increased to about half a million. The termination of the war left the Company's affairs both at home and abroad in great derangement, and the discussions which followed produced a general conviction that some new arrangement was necessary for the future government of their extensive territorial acquisitions. The principal measure adopted was the establishment of a board of control, composed of a certain number of commissioners appointed by the king, and removeable at his pleasure. This board was authorised to check, superintend, and control, the civil and military government and revenues of the Company, and to inspect the dispatches transmitted by the Directors to the different presidencies. The appointment of the Governor-general, President, or Counsellor in the different presidencies was made subject to the approbation and recal of his Majesty; and a tribunal was created for the trial of Indian delinquents. Some further regulations were adopted in 1786, the chief of which were, bestowing on the Governor-general of India, the high prerogative of deciding in opposition to the sense of the majority of the council; and uniting the offices of Commander in Chief and Governor General in the same person. The Company were empowered to increase their capital, by creating 800,000*l.* new stock, for which they obtained 1,240,000*l.* at the rate of 155 per cent.; and in 1789 they were authorised to add a million to their capital, which was effected at the rate of 174 per cent. and preference was given to such persons as were stockholders at the time of subscription. Their annual dividend at this time was 8 per cent. and continued at this rate till 1793, when, in pursuance of an agreement with govern-

ment for the renewal of their charter, another million was added to their capital, which thus became 6,000,000*l.* and the dividend was raised to 10½ per cent.

By the agreement in 1793, the term of their exclusive trade was continued, under various regulations, for 20 years from the 1st of March, 1794, with the former proviso, that if, after the expiration of that term, their right to the sole trade shall cease, in consequence of three years previous notice being given by parliament, and the repayment of such sums as may be then due from the public, they shall continue a corporation notwithstanding, with power to carry on a free trade in common with other persons.

The Company is under the management of twenty-four directors, elected by the proprietors of the Company's stock, who hold 1000*l.* or upwards. Such proprietors are likewise entitled to vote on all occasions, in the quarterly and special general courts of the Company.

Company, *South Sea.* The scheme for satisfying the national deficiencies by the establishment of this Company was arranged and brought forward in 1711 by Mr. Harley, then Chancellor of the Exchequer, and the opinion of its efficacy for retrieving the languishing state of public credit was so great, that upon his being created Earl of Oxford, this service was particularly mentioned in the patent as one of the chief reasons for advancing him to that honour. It certainly afforded considerable relief to government, by consolidating a variety of debts and arrears of interest, and making a general provision for them, which the expectation of gain from the commercial undertakings of the Company induced the proprietors readily to accept. These debts and deficiencies formed the first capital of the Company, which amounted to 9,177,967*l.* 15*s.* 4*d.* including half a million raised towards the current services of the year. In 1715 their capital was increased to 10,000,000*l.* and in 1719 to 11,746,844*l.* 8*s.* 10*d.*; but as all the sums thus subscribed into South Sea Stock consisted of public debts, which were thus transferred from the individual proprietors of them to the Company, it became necessary for the Company to borrow money on bonds, to enable them to undertake their ostensible object of trade to South America.

In 1720, the Company engaged in one of the most memorable projects ever attempted in Great Britain. It was founded upon an agreement with government, authorizing the Company to take in, either by subscription or purchase, all the public debts, at such prices as they could agree upon with the respective proprietors; and they were empowered to raise the money which would be necessary for making these purchases, either by calls upon their members, by annuities, bonds, or bills, or by opening subscriptions for new stock. It is difficult to conceive how the Company could expect to derive such permanent advantages from this transaction as would support any considerable increase of their dividend; yet the expectation of great profits was so general, as to excite the most extensive, though the most extravagant, infatuation that was ever known in money transactions in this country. South Sea Stock was soon sold at double the sum that had been paid in upon it, and in the course of a short time reached the enormous price of 1000 per cent. The rapidity of its fall, however, exceeded that by which it rose; for, before the end of the year, the difference of price was more than 800 per cent. in the course of only three weeks, by which thousands of persons suffered very severe losses, and many were entirely ruined.

The only branches of trade in which the Company ever engaged were, in supplying the Spanish colonies in America with negroes, and the Greenland whale-fishery. In both these undertakings the Company were considerable losers; in consequence of which, in 1748, they gave up the contract with Spain, and from that period have not carried on any branch of commerce whatever; their whole business being confined to transferring and paying the dividends on the public funds, known by the title of South Sea Stock, Old and New South Sea Annuities, and South Sea Annuities of 1751.

The Company is under the management of three governors and twenty-one directors. The whole expense of managing the concern in the year ending the 5th of January, 1807, was 10,727*l.*, of which 3692*l.* was paid to the sub and deputy governors and directors, and 4,735*l.* to 36 officers and clerks employed by them. The sum annually paid by the public to the South Sea Company is 14,713*l.* 10*s.* 6*d.*, and about 70*l.* for fees and allowances to the cashier.

Company, *Hudson's Bay*, was established in 1670, by charter, granted by Charles II. to his cousin Prince Rupert, and seventeen other persons of distinction, who were incorporated for carrying on an exclusive

trade to all parts of Hudson's Bay, and invested with great powers and privileges. The establishment excited the jealousy of the French, who in 1686 seized on all their forts or factories, except that at Port Nelson; they were, however, retaken in 1693; but they have been annoyed by the same power at several subsequent periods: and in 1782 a French squadron, under La Pérouse, destroyed the settlements, forts, merchandise, &c. of the company, to the supposed value of about 500,000*l.* sterling, but without retaining possession of the place.

The Company's charter not being confirmed by parliament, they have no right in law to an exclusive trade; but the nature of the trade is such that private adventurers cannot engage in it in competition with them. The Company is under the direction of a governor, deputy governor, and a committee of seven members: their capital stock is said not to exceed 110,000*l.*, which is in the hands of a very small number of proprietors.

Company, *Sierra Leone*, was instituted in the year 1791, with a capital of about 230,000*l.* The general object of the subscribers was the introduction of civilization into Africa, for effecting which end they proposed to establish a secure factory at Sierra Leone, with the view to a new trade in produce, chiefly with the interior of the country; but the reception into the settlement of near 1200 blacks from Nova Scotia, in March, 1792, produced much embarrassment, which was increased in 1793 by the war, which interrupted their trade, and subjected them to depredations. In 1794 the colony was attacked and taken by the French, who destroyed every description of property belonging to the Company, by which they sustained a loss of about 52,000*l.* In 1798, however, the colony had so far recovered as to contain about 1200 inhabitants; the heads of families were about 300; of whom about one half were supported by their farms, many were mechanics, about 15 were retail shopkeepers, 20 or 25 followed the business of fishing, 10 or 15 traded in small vessels of their own, 4 were employed as schoolmasters, 12 or 15 as seamen, and about 20 as labourers under the Company; from 3 to 400 native labourers worked in the settlement for hire, chiefly on the farms, which were increasing rapidly.

Further difficulties and losses have been experienced, from an insurrection of the Nova Scotians in 1800, and an attack of some of the neighbouring tribes in 1801, but the colony is now possessed of more effectual means of defence, and a great impediment to its progress has been done away by the abolition of the slave trade.

Company, *Dutch East India.* This once celebrated establishment was formed by the union of a number of separate companies in 1602: it carried on for many years a very flourishing trade, which has since declined very rapidly, particularly from about the year 1770, and in 1799 it was entirely suspended. The Dutch have likewise had West India Companies, a Levant Company, Companies for the Baltic sea, the whale fishery, &c.

Company, *French East India*, was established in 1664, but never became of much importance. In 1769 the trade was laid open. A new Company was established in 1785, but was abolished in 1790. The other commercial Companies of France were principally a West India Company, a St. Domingo Company, the Senegal Company, the Mississippi Company, the Company of the West, and the Bastion Company.

Company, *Danish East India*, and also the Swedish East Company, still possess a share in the commerce of the East, although it is not very considerable.

Company, in military affairs, a small body of foot, commanded by a captain, who has under him a lieutenant and ensign.

The number of centinels, or private soldiers in a company, may be from 50 to 80; and a battalion consists of thirteen such companies, one of which is always grenadiers, and posted on the right; next them stand the eldest company, and on the left the second company; the youngest one being always posted in the centre.

Companies not incorporated into regiments are called irregulars, or independent companies.

Company *of ships*, a fleet of merchantmen, who make a charter-party among themselves, the principal conditions whereof usually are, that certain vessels shall be acknowledged admiral, vice-admiral, and rear-admiral; that such and such signals shall be observed; that those which bear no guns shall pay so much per cent. of their cargo; and in case they be attacked, that what damages are sustained shall be reimbursed by the company in general. In the

Mediterranean such Companies are called Conserves.

COMPARATIVE *anatomy*, is the science which examines the structure of the body in animals. It includes, in its most extensive sense, a view of the corporeal organization of all classes of the animal kingdom.

This science, which is very aptly denominated comparative anatomy, affords the most essential aid in elucidating the structure of the human body, and in explaining the doctrines of physiology.

The want of any organ in certain classes of animals, or its existence under different modifications of form, structure, &c. cannot fail to suggest most interesting conclusions concerning the office of the same part in the human subject. Thus our physiological reasonings, which must necessarily be partial and incomplete, when deduced from the structure of a single animal or class, are extended and corrected by this general comparative survey, and may, therefore, be relied on with the greater confidence. We are indebted to such investigations for the discovery of the circulation and of the lymphatic system; for the elucidation of the functions of digestion and generation: indeed, there is no branch of anatomy or physiology which has not received most material benefit from the same source. Hence Haller has very justly observed, that "physiology has been more illustrated by comparative anatomy, than by the dissection of the human body."

The study of comparative anatomy is moreover of the greatest importance in its connection with veterinary science, and with that highly interesting pursuit, natural history. It would be an affront to our readers to enlarge upon its utility in the former point of view; but we may be allowed to observe on the latter subject, that anatomical structure forms the only sure basis of a natural classification of the animal kingdom; and that any arrangement not founded on this ground-work will lead us into the most gross and palpable errors.

Lastly, this study opens to the mind a great source of interest and satisfaction, in exhibiting such numerous and undeniable proofs of the exertion of contrivance and design in the animal structure: in displaying those modifications of particular parts and organs, by which they are adapted to the peculiar circumstances of the animal, and become subservient to its wants, its necessities, or its enjoyments.

The importance of the subject from the above-mentioned circumstances is now so fully recognised, that it begins with justice to be considered as an essential part of a regular medical education. Public lectures have been delivered on it for some years in Germany and France; and lately the example has been followed in this metropolis.

Hitherto there has been rather a deficiency of good works on this science, and particularly of elementary books. Blasius has given a collection of the writings of several authors on the anatomy of particular animals, in one volume 4to., entitled "Anatomia animalium figuris variis illustrata," Amstel. 1681; which may still be consulted with advantage, particularly on account of the plates. Cuvier's "Leçons d'Anatomie comparée," in five large 8vo. volumes, form a very valuable and useful repository of facts in comparative anatomy; but the subject is treated at such length, and with so many uninteresting details, that the book is by no means adapted for the use of students. The only compendious and scientific view of the subject which we can recommend to beginners is the short system published by Blumenbach of Gottingen, and translated from the German by Mr. Lawrence, who has accompanied it with numerous additional notes.

The necessity of confining this article within a given number of pages renders it impossible for us to give a general view of the subject; we shall, therefore, select such parts as are either particularly interesting in themselves, or such as become important from elucidating the structure or functions of the human body.

It is necessary for us to make a few remarks on the classification of the animal kingdom; as the terms employed in the following article differ occasionally from those of the Linnæan system, which has been hitherto chiefly used in this country; and, independently of this circumstance, such of our readers as have not particularly attended to the study of natural history, may derive assistance and information from a short sketch and explanation of the arrangement of animals according to their anatomical structure, with an enumeration of the chief genera in each order.

That the Linnæan system is exposed to numerous and well-grounded objections, and that in many instances it disregards anatomical structure, which should form he basis of a natural classification, will be

readily allowed by the most sanguine admirers of its illustrious author. Yet it must be remembered, that the general adoption of this method renders it desirable to deviate from it in as few instances as possible; since the introduction of new orders and names must necessarily create difficulty and confusion in the study of the science. The French zoologists, whose successful labours in the advancement of natural history must be acknowledged with every due tribute of respect, have carried the rage of innovation too far, in the universal rejection of the Linnæan method, and the unnecessary multiplication of new orders and genera. The defects or errors of any system could not cause so much perplexity and inconvenience as the want of a generally received standard, and the unlimited licence, in which every individual indulges, of fabricating new classifications and arrangements. To judge by some recent works, we should be led to suppose, that the merit of a systematic arrangement of animals does not consist in the simplicity or intelligibility of the system; but is in proportion to the number of newly-created terms.

Animals may be distributed into two grand divisions: those which have a vertebral column, and red-blood; and those which have no vertebræ, and are white blooded.

In the former division there is always an interior skeleton; the chief support of which is the column of vertebræ; a spinal marrow contained in the vertebral canal; never more than four members, of which one or both pairs are wanting in some instances. The brain is contained in a cranium: there is a great sympathetic nerve; five senses; two moveable eyes; and three semicircular canals in the ear. The circulation is performed by one muscular ventricle at least. There are lymphatic as well as blood vessels. The jaws being placed horizontally, the mouth is opened by their moving from above downwards, or from before backwards. There is a continuous alimentary canal, extending from the mouth to the anus, which is always placed behind the pelvis; peritoneum; liver, spleen, and pancreas; two kidneys, and renal capsules; and two testicles.

The vertebral animals are subdivided into the warm and cold-blooded.

Warm blooded vertebral animals have two ventricles in the heart, and a double circulation; and breathe by means of lungs. The cranium is completely filled by the brain. The eyes are closed by eyelids. The tympanum of the ear is hollowed out of the cranium, and the labyrinth is excavated in the bone. Besides the semicircular canals, the ear has a cochlea. The nostrils communicate with the fauces, and allow the passage of air into the lungs. The trunk is constantly furnished with ribs.

In cold blooded vertebral animals the brain never entirely fills the cranium. The eyes seldom possess moveable eyelids. When the tympanum exists, it is on a level with the surface of the head. There is no cochlea. The different parts of the ear are connected but loosely to the cranium.

The division of warm blooded animals contains two classes; Mammalia and Birds.

The mammalia are viviparous, and suckle their young, from which circumstance the name is derived. They have an uterus with two cornua; and the male has a penis.

There are two occipital condyles, connecting the head to the atlas: never less than six, nor more than nine cervical vertebræ: a very complicated brain; four ossicula auditus, and a spiral cochlea. The skin covered with hair. A muscular diaphragm separates the chest and abdomen. There is an epiglottis. The lower jaw only moves. The fluid in the lacteals is white, and passes through several conglobate glands. There is an omentum.

Blumenbach establishes the following orders in this class:

I. *Bimanum*. Two handed.
Genus 1. Homo.

II. *Quadrumana*, four handed animals; having a separate thumb, capable of being opposed to the other fingers, both in their upper and lower extremities. Teeth like those of man, except that the cuspidati are generally longer.

1. Simiæ, apes, monkeys, baboons.
2. Lemur, macauco.

III. *Bradypoda*, slow-moving animals.

1. Bradypus, sloth.
2. Myrmecophaga, ant-eater.
3. Manis, scaly-lizard, or pangolin.
4. Dasypus or Tatu, armadillo.

This order forms two in the arrangement of Cuvier. 1st. Tardigrada; which includes the sloths. There are no incisors in either jaw; there is a complicated stomach, but no rumination. 2dly. Edentata, toothless animals. Some of these have no teeth; others want the incisores and cuspidati. The tongue is long, slender, and projectile,

for seizing the insects on which the animals feed; body covered with hard substances. The armadillo, manis, ant-eater, and ornithorhyncus, or duck-billed animal, belong to this order.

IV. *Cheiroptera*, having the fingers elongated for the expansion of a membrane, which acts as a wing.

Vespertilio, bat.

V. *Glires*. Rodentia of Cuvier—gnawing animals. Have two long and very large incisor teeth in each jaw, by which they cut and gnaw hard bodies, chiefly vegetables; there is a large interval behind these teeth, unoccupied by cuspidati; long intestines, and generally a large cœcum. The hind legs, being longer than the front extremities, give to these animals a leaping mode of progression. The disproportion is sometimes so great that the front legs are not used in walking. A bone in the penis.

1. Sciurus, squirrel.
2. Glis, dormouse (Myoxus Linn.)
3. Mus, mouse and rat.
4. Marmota, marmot.
5. Cavia, guinea-pig.
6. Lepus, hare and rabbit.
7. Jaculus, jerboa.
8. Castor, beaver.
9. Hystrix, porcupine.

VI. *Feræ*, predaceous and carnivorous animals. Very strong and large pointed canine teeth: molares forming pointed prominences; short and simple alimentary canal, and consequently slender belly.

1. Erinaceus, hedge-hog.
2. Sorex, shrew.
3. Talpa, mole.
4. Meles, badger.
5. Ursus, bear.
6. Didelphis, opossum, kanguroo.
7. Viverra, weasels, ferret, polecat, civet.
8. Mustela, skunk, stoat, &c.
9. Canis, dog, wolf, jackal, fox, hyena.
10. Felis, cat, lion, tiger, leopard, lynx, panther, &c.
11. Lutra, otter.
12. Phoca, seal or sea-calf.

The five first genera of this order, form the plantigrada of Cuvier; animals which rest the whole of the foot on the ground. They are less carnivorous than the others; have a longer intestinal canal, and no cæcum.

The sixth genus forms the Pedimana of the same zoologist; as they possess a separate thumb on the hind extremities only. They have a pouch in the abdomen containing the mammæ, and holding the young in their early state. One species, the kanguroo, (didelphis gigantea) must however be excepted. That is placed among the rodentia, and does not possess the separate thumb.

The order carnivora of Cuvier, will include from the 7th to the 11th genus: both inclusive. These have a bone in the penis. The seal belongs to this amphibia.

In the three following orders the toes are so incased in horny coverings, that they can only serve to support the body in standing or progression. As these animals all feed on vegetables, the intestines are very long, and the belly consequently large.

VII. *Solidungula* (solipeda Cuvier), a single toe on each foot, with an undivided hoof; a small and simple stomach, but large intestines, and particularly an enormous cæcum; incisors in both jaws; mammæ in the groin, as in the pecora.

1. Equus, horse and ass.

VIII. *Pecora* or *Bisulca* (ruminantia of Cuvier), a divided hoof. No incisores in the upper jaw, where their place is supplied by a callous prominence; stomach consisting of four cavities; rumination of the food; long intestines. Their fat becomes hard and brittle when cold. The mammæ are placed between the posterior extremities. The penis of the male has no bone.

1. Camelus, camel, dromedary, lama.
2. Capra, sheep, goat.
3. Antilope, antelope, chamois.
4. Bos, ox, buffalo.
5. Giraffa, giraffe or camelopard.
6. Cervus, elk, deer-kind.
7. Moschus, musk.

IX. *Belluæ*, animals of an unshapely form, and a tough and thick hide; whence they have been called by Cuvier, pachydermata (from παχυς thick, and δερμα skin). They have more than two toes; incisors in both jaws, and in some cases enormous tusks; mammæ extend under the belly, where they are numerous.

1. Sus, pig kind, pecari, babiroussa.
2. Tapir.
3. Elephas.
4. Rhinoceros.
5. Hippopotamus.
6. Trichecus, morse or walrus, manati or sea-cow.

The last genus of this order, together with the phoca (seals) constitutes the Am-

phibia of Cuvier. These animals have short members adapted for swimming.

X. *Cetacea*, whales, living entirely in the sea, and formed like fishes; breathe by an opening at the top of the head, called the blowing hole; through which they throw out the water, which enters their mouth with the food; smooth skin covering a thick layer of oily fat; no external ear; a complicated stomach; multilobular kidneys; larynx of a pyramidal shape, opening towards the blowing hole; testes within the abdomen; mammæ at the sides of the vulva; bones of the anterior extremity concealed and united by the skin, so as to form a kind of fin; no posterior extremities; teeth which retain their prey, but do not masticate, and instead of which there are sometimes layers of a horny substance called whalebone.

1. Monodon, narwhal, sea-unicorn.
2. Balæna, proper whales.
3. Physeter.
4. Delphinus, dolphin, porpoise.

Cuvier distributes the class mammalia into three grand divisions:

1. Those which have claws or nails (mammiféres a ongles): including the following orders: bimana, quadrumana, cheiroptera, plantigrada, carnivora, pedimana, rodentia, edentata, tardigrada.
2. Those which have hoofs (mammif. a ongles) including the pachydermata, ruminantia, and solipeda.
3. Those which have extremities adapted for swimming (mammif. a pieds en nageoire). Amphibia and cetacea.

Birds are oviparous: have a single ovary and oviduct; a single occipital condyle; very numerous cervical vertebræ; a very large sternum; and anterior extremities adapted for flying, the posterior only being used for walking.

They have three eyelids; no external ear; a bone in the tongue; a cochlea conical, but not spiral; a single ossiculum auditus; body covered with feathers. The lungs are attached to the surface of the chest, and penetrated by the air, which goes all over the body; no diaphragm; there is a larynx at each end of the trachea; no epiglottis: the jaws are covered with a horny substance, and are both movable; there are no lips, gums, nor teeth; the chyle is transparent; no mesenteric glands, nor omentum; no bladder of urine, the ureters terminating in a bag through which the eggs and fæces come, *viz.* the cloaca; the pancreas and liver have both several ducts entering the intestine; spleen in the centre of the mesentery.

This class cannot be distributed into orders so clearly distinguished by anatomical characters as the preceding one. Blumenbach divides them into two leading divisions.

(A) TERRESTRIAL BIRDS.

Order I. *Accipitres*. Birds of prey, with strong hooked bills, and large curved talons, a membranous stomach, and short cæca.

1. Vultur, vultures.
2. Falco, falcon, eagle, hawk, kite.
3. Strix, owl.
4. Lanius, shrike or butcher bird.

II. *Levirostres*, light-billed birds, having a large hollow bill.

1. Psittacus, parrot kind.
2. Ramphastos, toucan.
3. Buceros, rhinoceros bird.

III. *Picæ*, this and the two following orders are not clearly characterised.

1. Picus, woodpecker.
2. Jynx, wryneck.
3. Sitta, nuthatch.
4. Alcedo, king's-fisher.
5. Trochilus, humming bird, &c. &c.

IV. *Coraces*.

1. Corvus, crow, raven, jackdaw, magpie, jay, &c.
2. Coracias, roller.
3. Paradisea, birds of paradise.
4. Cuculus, cuckoo, &c. &c.

V. *Passeres*, small singing-birds.

1. Alauda, lark.
2. Sturnus, starling.
3. Turdus, thrush, blackbird.
4. Emberiza, bunting.
5. Fringilla, finches, canary-bird, linnet, sparrow.
6. Motacilla, nightingale, redbreast, wren.
7. Hirundo, swallows, martins, &c.
8. Caprimulgus, goatsucker, &c.

VI. *Gallinæ*, gallinaceous birds, mostly domesticated. They possess a large crop, strong muscular gizzard, short legs.

1. Columba, pigeons.
2. Tetrao, grous, quail, partridge.
3. Numida, guinea-fowl.
4. Meleagris, turkey.
5. Pavo, peacock.
6. Otis, bustard.

VII. *Struthiones*, struthious birds. The largest of the class: possess extremely small wings, and are therefore incapable of flight; but run very swiftly.

1. Struthio, ostrich.
2. Casuarius, cassowary or emu.

(B) AQUATIC BIRDS.

Order I. *Grallæ*, waders, frequenting marshes and streams; long naked legs; long neck; cylindrical bill of different lengths.

1. Ardea, crane, stork, heron, bittern.
2. Scolopax, woodcock, snipe, curlew.
3. Tringa, lapwing, ruffs, and reeves.
4. Charadrius, plover.
5. Fulica, coot.
6. Rallus, rail.
7. Phœnicopterus, flamingo.
8. Tantalus, ibis, &c.

II. *Anseres*, swimming birds; web-footed; bill, broad and flat, covered by a somewhat soft substance, on which large nerves are distributed.

1. Colymbus, diver.
2. Larus, gull.
3. Procellaria, petrel.
4. Diomedea, albatross.
5. Pelecanus, pelican, cormorant.
6. Anas, swan, duck, goose.
7. Mergus, goosander.
8. Alca, auk, puffin.
9. Aptenodytes, penguin.

The two classes of cold-blooded vertebral animals are the Amphibia and Fishes.

The former, differing considerably from each other, have very few common characters; for in different instances they walk, fly, swim, and crawl. There is no external ear, nor cochlea; the brain is always very small; the lungs are in the same cavity with the other viscera, and have very large air-cells; no epiglottis, omentum, nor mesenteric glands; two ovaries and oviducts; cloaca, through which the fæces and urine are expelled, and in which the organs of generation terminate; neither hair, feathers, nor mammæ; skin either naked, or covered with scales; both jaws are moveable; there is an urinary bladder.

Order I. *Reptilia*, having four feet, *(quadrupeda ovipara.)*

1. Testudo, tortoise, turtle.
2. Rana, frog, toad.
3. Lacerta, lizards, crocodile, chameleon, newt, salamander, iguana, &c.

II. *Serpentia*. No external members; body of an elongated form, and viscera of a similar shape; they are oviparous; but the egg is sometimes hatched in the oviduct; both jaws moveable.

1. Crotalus, rattlesnake.
2. Boa. Immense serpents of India and Africa.
3. Coluber, viper.
4. Anguis, blindworm.
5. Amphisbæna.
6. Cæcilia.

Fishes. Breathe by means of branchiæ or gills; and have no trachea, nor larynx; organs of motion consisting of fins; nose unconnected with the organs of respiration; ear entirely inclosed in the head, the tympanum, &c. being absent; both jaws moveable; the place of the pancreas supplied by the pyloric cæca; an urinary bladder; two ovaries; heart consisting of a single auricle and ventricle. They may be distributed into two leading divisions: the cartilaginous, whose skeleton consists of cartilage; the bony, where it is formed of a more firm substance.

(A) CARTILAGINOUS FISHES.

Order I. *Chondropterygii*; having no gill-cover; an uterus, with two oviducts.

1. Petromyzon, lamprey.
2. Gastrobranchus.
3. Raia, skate, torpedo, stingray.
4. Squalus, shark, saw-fish.
5. Lophius, sea-devil, frog-fish.
6. Balistes, file-fish.
7. Chimæra.

II. *Branchiostegi*; having a gill-cover.

1. Accipenser, sturgeon, beluga.
2. Ostracion, trunk-fish.
3. Tetrodōn.
4. Diodon, porcupine-fish.
5. Cyclopterus, lumpsucker.
6. Centriscus.
7. Syngnathus, pipe-fish.
8. Pegasus.

(B) BONY FISHES, DIVIDED ACCORDING TO THE SITUATION OF THEIR FINS.

Order I. *Apodes*; no ventral fins.

1. Muræna, eel-kind.
2. Gymnotus, electrical eel.
3. Anarrhichas, sea-wolf.
4. Xiphias, sword-fish.

5. Ammodites, launce.
6. Ophidium.
7. Stromateus.
8. Trichiurus.

II. *Thoracici;* ventral fins directly under the thoracic.

1. Echeneis, sucking fish.
2. Coryphæna, dorado.
3. Zeus, dory.
4. Pleuronectes, flounder, plaice, dab, holibut, sole, turbot.
5. Chætodon.
6. Sparus.
7. Perca, perch.
8. Scomber, mackarel, bonito, tunny.
9. Mullus, mullet, &c. &c.

III. *Abdominales;* ventral fins behind the thoracic; chiefly inhabit fresh water.

1. Cobitis, loach.
2. Silurus.
3. Salmo, salmon, trout, smelt.
4. Esox, pike.
5. Clupea, herring, sprat, shad.
6. Cyprinus, carp, tench, gold-fish, minow, &c. &c.

IV. *Jugulares;* ventral fins in front of the thoracic.

1. Gadus, haddock, cod, whiting, ling.
2. Uranoscopus, star-gazer.
3. Blennius, blenny.
4. Callionymus, dragonet.
5. Trachinus, weaver.

The animals which have no vertebral column, do not possess so many common characters as the vertebral classes; their hard parts, when they have any, are generally placed on the surface of the body; the centre of the nervous system, instead of being nclosed in a bony case, lies in the same cavity with the viscera; the œsophagus is generally surrounded by a nervous chord coming from the brain; their respiration is not carried on by lungs, and they have no voice; their jaws move in various directions; they have no urinary secretion.

The invertebral animals were distributed by Linnæus into two classes; insects and worms (vermes). The anatomical structure of these animals was very imperfectly known, when the Swedish naturalist first promulgated his arrangement. But the labours of subsequent zoologists, and particularly those of Cuvier, have succeeded in establishing such striking and important differences in their formation, that a subdivision of the Linnæan classes became indispensably necessary. The insects of Linnæus are divided into crustacea and insecta: and the vermes of the same author form three classes; *viz.* Mollusca, Vermes, and Zoophyta.

The Mollusca derive their name from the soft fleshy nature of their body. This class includes those pulpy animals, which may either be destitute of an external covering, when they are called mollusca nuda, as the slug; or may be inclosed in one or more shells, as the snail, oyster, &c. when they are termed testacea.

The animals of this class have no articulated members; they have blood-vessels, and a true circulation; they respire by means of gills; they have a distinct brain, giving origin to nerves; and a spinal marrow.

1. Sepia, cuttlefish.
2. Argonauta.
3. Nautilus.
4. Limax, slug.
5. Aplysia.
6. Doris.
7. Clio.
8. Patella, limpet.
9. Helix, snail.
10. Haliotis, Venus's ear.
11. Murex, caltrop, or rockshell.
12. Strombus, screw.
13. Buccinum, whelk.
14. Ascidia.
15. Thalia.
16. Ostrea, oyster.
17. Solen, razorshell.
18. Cardium, cockle.
19. Mytilus, muscle, &c. &c.

Cuvier classes the numerous genera of this order under the three following divisions: 1. Cephalopoda, (from κεφαλη the head, and πυς the foot) which have their organs of motion placed round the head; 2. Gasteropoda, (from γαςηρ the belly, and πυς), such as crawl on the belly; and 3. Acephala, (from α privative, and κεφαλη), which have no head. The three first genera belong to the first division; the ten succeeding ones come under the second; and the remainder exemplify the last order.

According as the shell of the testaceous mollusca consists of a single convoluted tube; or of two or more separate pieces, they are called cochleæ bivalves, multivalves, &c.

Crustacea possess a hard external covering, and numerous articulated members;

a long nervous chord, beset with ganglia; compound eyes; antennæ and palpi like those of insects; a heart and circulating vessels, and gills; teeth in the cavity of the stomach.

1. Cancer, crab, lobster, crayfish, shrimp.
2. Monoculus.

Insects have articulated members and antennæ. Those which fly are subject to what is called a metamorphosis; they pass through certain intermediate states of existence, before they assume the last, or perfect form. From the egg proceeds the larva, or caterpillar; this changes to the chrysalis, nympha, or aurelia, from which the perfect insect is produced; nervous system consisting of a chord beset with ganglia; no heart nor blood-vessels; respiration carried on by means of tracheæ.

Order I. *Coleoptera*; having a hollow, horny case, under which the wings are folded.

1. Scarabæus, beetles.
2. Lucanus, stag-beetle.
3. Dermestes.
4. Coccinella, ladybird.
5. Curculio, weevil.
6. Lampyris, glow-worm.
7. Meloe, Spanish-fly.
8. Staphylinus.
9. Forficula, earwig.

II. *Hemiptera*; four wings, either stretched straight out, or resting across each other.

1. Blatta, cockroach.
2. Gryllus, locust, grasshopper.
3. Fulgora, lantern-fly.
4. Cimex, bug, &c.

III. *Lepidoptera*; soft hairy body, and four expanded wings.

1. Papilio, butterfly.
2. Sphinx, } moths.
3. Phalæna, }

IV. *Neuroptera*; four reticulated wings.

1. Libellula, dragon-fly.
2. Ephemera, &c.

V. *Hymenoptera*; generally possessing a sting.

1. Vespa, wasp, hornet.
2. Apis, bee.
3. Formica, ant.
4. Termes, white ant.
5. Ichneumon, &c.

VI. *Diptera*; two wings.

1. Œstrus, gad-fly.
2. Musca, common flies.
3. Culex, gnat, mosquito.
4. Hippobosca, horse-leech, &c.

VII. *Aptera*; no wings.

1. Podura, springtail.
2. Pediculus, louse.
3. Pulex, flea, chigger.
4. Acarus, tick, mite.
5. Aranea, spiders.
6. Scorpio, scorpion, &c.

The vermes may be divided into two orders; the intestinal, which inhabit the bodies of other animals; and the external.

The former are not of such a complicated organization as the latter; so that they are sometimes arranged among the zoophytes. The external worms have a nervous chord possessing ganglia, an elongated body composed of rings, and having no distinct head; there are no members; circulating vessels, but no heart; no nerves have been discovered in the intestinal worms.

Order I. *Intestini.*

1. Gordius, guinea-worm.
2. Ascaris, thread-worm, round-worm.
3. Tricocephalus.
4. Fasciola, fluke.
5. Tænia, tape-worm.
6. Hydatis, hydatid.

II. *Externi.*

1. Aphrodite, sea-mouse.
2. Sipunculus.
3. Hirudo, leech.
4. Nereis.
5. Nais.
6. Planaria.
7. Lumbricus, earthworm, &c.

The Zoophytes have neither brain nor nerves; no heart, nor, perhaps, blood-vessels; no articulated members.

Order I. *Echinodermata*; covered by a hard and tough coriaceous skin.

1. Echinus, sea hedgehog.
2. Asterias, star-fish, &c.

II. *Soft* or *Gelatinous Zoophytes.*

1. Medusa, sea-blubber, sea-nettles.
2. Actinia, sea-anemone.
3. Hydra, fresh water polype.

III. *Infusoria*, the animalcules of infusions.

1. Vorticella, wheel-animal.
2. Brachionus.
3. Vibrio, eel of vinegar.
4. Volvox.
6. Monas.

IV. Inhabitants of corals, corallines, sponges, &c.

COMPARATIVE OSTEOLOGY.

It has been asserted, that the bones in some instances have not their ordinary white colour. Thus the amedabad finch, (fringilla amandava,) and the golden pheasant, have been said to possess yellow bones; but this is not true. In the garpike (esox belone) the bones are green; and in some varieties of the common fowl in the East Indies they are black; but this colour is said by Mr. Hunter to reside in the periosteum.

The opinion of Aristotle, that the bones of the lion had no marrow, is totally unfounded.

The bones of the cranium are much more completely ossified at the time of birth, in the mammalia, than in man. In the former the fontanells are hardly discernible. When we compare the pelvis, and the whole mechanism of parturition in the woman, with those of the female quadruped, the cause of this difference appears, we then discover, why the yielding and over lapping of the large bones of the cranium, which is chiefly effected by the fontanells, is only required to facilitate the birth of the human fetus.

The skeleton remains constantly cartilaginous in some animals; such as the skate, shark, sturgeon, and all those fishes, which, from this circumstance, have been denominated cartilaginous. The bones of birds are almost universally hollow; but their cavities, which never contain marrow, are filled with air. This organization unites the advantages of strength and lightness.

Crustaceous animals, (crab, lobster, &c.) have a skeleton which surrounds and contains their soft parts, and which serves at the same time the purposes of a skin. When it has attained its perfect consistence, it grows no more: but as the soft parts still increase, the shell separates, and is detached, being succeeded by a larger one. This new covering is partly formed before the other separates: it is at first soft, sensible, and vascular; but it speedily acquires a hard consistence by the increased deposition of calcareous matter.

Some of the mollusca have hard parts in the interior of their body. The common cuttlefish (sepia officinalis) has a white, firm, and calcareous mass of an oval form, and slightly convex on its two surfaces, commonly known by the name of the cuttlefish-bone, contained in the substance of its body. It has no connection with any soft part, whence it appears completely as a foreign body: no vessel nor nerve can be perceived to enter it; nor does it receive the attachment of any tendon. In the calmar (sepia loligo), this body resembles horn in its appearance; it is transparent, hard, and brittle. Its form resembles that of a leaf, except that it is larger; and sometimes that of a sword-blade. These parts must grow like shells, by the simple addition of successive layers.

In the vertebral animals, the bony parts of the body are composed of a gelatinous substance, united to phosphate of lime. But in the lower orders of animals, the hard parts are composed chiefly or entirely of carbonate of lime. This is the case with the shells of all the testacea.

SKELETON OF MAMMALIA.

The form of the different mammalia, particularly the fourfooted ones, varies considerably; and their skeletons must be marked by corresponding differences. Yet these varieties may be included, at least for the greatest part, under the following peculiarities; which serve to distinguish their skeletons from those of birds.

The skeletons of mammalia possess:	Those of birds are distinguished by:
1. A skull with genuine sutures, at least with very few exceptions; as perhaps the elephant, and the duck-billed animal (ornithorhyncus).	1. A skull which has not real sutures, at least in the adult.
2. Jaws furnished with teeth. Except the anteaters, the manis, the balæna (whale).	2. A bill without teeth.
3. An upper jaw, which does not move.	3. An upper jaw, which does move. There are some exceptions, *viz.* the rhinoceros bird.

4. An os intermaxillare.	4. No os intermaxillare.
5. Two occipital condyles.	5. A single occipital condyle.
6. Seven cervical vertebræ. Except the three-toed sloth, and some cetacea.	6. More than seven cervical vertebræ.
7. Moveable dorsal vertebræ.	7. Motionless dorsal vertebræ.
8. A pelvis closed in front. Except the ant-eaters; which have it open: and the cetacea, which have none.	8. A pelvis open anteriorly. Except the ostrich.
9. True clavicles in a few genera only.	9. Clavicles constantly; and almost as universally the forklike bone.

The structure of the cranium presents a very remarkable singularity in the elephant. Its two tables are separated from each other to a considerable extent, by numerous bony processes; between which are formed a vast number of cells, communicating with the throat by means of the eustachian tube, and filled with air instead of the bloody or medullary substance, which occupies the diplöe of animals. The use of this structure in increasing the surface for attachment of those large muscles, which belong to the lower jaw, proboscis and neck; and in augmenting the mechanical power of these muscles, by removing their attachments to a greater distance from the centre of motion, has been very ingeniously explained by Camper. (Œuvres, tom. 2). These advantages are attained by the cellular structure, which we have just described, without augmenting the weight of the head, and this precaution is particularly necessary in the present instance, as the head is on other accounts more heavy and massy in this than in any other animal. The air cells of birds, in general, and particularly those which pervade the cranium in the ostrich, eagle, and owl, present examples of a similar formation, attended with the same uses; *viz.* those of increasing the bulk and strength of the bone, and diminishing its weight.

A comparison of the human cranium, with that of animals, will lead us to some interesting conclusions. Daubenton fixed on the situation of the foramen magnum occipitale, as a point of comparison. He draws two lines, which intersect each other in the profile of the skull: one passes from the posterior margin of the great foramen, (which, in almost all mammalia, is also the superior one,) through the lower edge of the orbit; the other takes the direction of the opening itself, beginning at its posterior edge, and touching the articular surface of the condyles. He determines, according to the angle formed by the junction of these two lines, the similarity or diversity of the form of crania.

This angle is, however, but an imperfect criterion; for its variations are included between 80° and 90° in almost all quadrupeds, which differ very essentially in other points. And small variations occur in the individuals of one and the same genus.

The variations in the situation of the occipital foramen are important, when viewed in connection with the ordinary position of the animal's body. In man, who is designed to hold his body erect, this opening is nearly equi-distant from the anterior and posterior extremities of the skull. The head therefore is supported in a state of equilibrium on the vertebral column. The angle, formed by the two lines mentioned by Daubenton, is only of three degrees.

Quadrupeds, which go on all-fours, have the occipital foramen and condyles situated farther back, in proportion as the face is elongated. That opening, instead of being nearly parallel to the horizon, forms a considerable angle with it; which, measured, according to Daubenton, is of 90 degrees in the horse. The weight of the head in these animals, is not therefore sustained by the spine; but by a ligament of immense strength, which is either entirely deficient, or so weak, as to have its existence disputed in the human subject. This ligamentum muchæ, or cervical ligament, arises from the spines of the dorsal and cervical vertebræ, (which are remarkably long for that purpose) and is fixed to the middle and posterior part of the occipital bone. It is of great size and strength in all quadrupeds, but most particularly in the elephant; where the vast weight of the head, so much increased by the enormous size of the tusks, sufficiently accounts for its increased magnitude. It is bony in the mole, probably on account of the use which the animal makes of its head, in disengaging and throwing up the earth.

Animals of the genus Simia and Lemur hold a middle rank between man, who is constantly erect, and quadrupeds, whose body is supported by four extremities. Their structure is by no means calculated, like that of man, for the constant maintenance of the erect posture; but they can support it with greater facility, and for a longer time than other animals. Hence, in the orang-outang, the occipital foramen is only twice as far from the jaws as from the back of the head; so that Daubenton's angle is only of 37°. It is somewhat larger in the other species of Siniæ, and measures 47° in the lemur.

The general form of the cranium is most materially influenced by the direction, and the various degrees of prominence of the facial bones.

To determine this with greater precision, Camper instituted the facial line; the application of which is most minutely explained in his posthumous work, "On the natural Differences of the Features, &c." Like Daubenton, he draws on the profile of the cranium two straight lines, which intersect each other; but in different directions from those of the French anatomist. An horizontal line passes through the external auditory passage, and the bottom of the cavity of the nose; this is intersected by a more perpendicular one, proceeding from the convexity of the forehead, to the most prominent point of the upper jaw, or of the intermaxillary bone. The latter is the proper facial line; and the angle, which it forms with the horizontal line, determines, according to Camper, the differences of the crania of animals, as well as the national physiognomy of the various races of mankind.

The two organs which occupy most of the face, are those of smelling and tasting (including those of mastication, &c). In proportion as these parts are more developed, the size of the face, compared to that of the cranium, is augmented. On the contrary, when the brain is large, the volume of the cranium is increased in proportion to that of the face. A large cranium and small face indicate therefore a large brain, with inconsiderable organs of smelling, tasting, masticating, &c.; while a small cranium, with a large face, shew that these proportions are reversed.

The nature and character of each animal must depend considerably on the relative energy of its different functions. The brain is the common centre of the nervous system. All our perceptions are conveyed to this part, as a sensorium commune: and this is the organ by which the mind combines and compares these perceptions, and draws inferences from them; by which, in short, it reflects and thinks. We shall find that animals partake in a greater degree of this latter faculty, or at least approach more nearly to it, in proportion as the mass of medullary substance, forming their brain, exceeds that which constitutes the rest of the nervous system; or, in other words, in proportion as the organ of the mind exceeds those of the senses. Since then the relative proportions of the cranium and face indicate also those of the brain and the two principal external organs, we shall not be surprised to find that they point out to us, in great measure, the general character of animals; the degree of instinct and docility which they possess. Man combines by far the largest cranium, with the smallest face; and animals deviate from these relations in proportion as they increase in stupidity and ferocity.

One of the most simple methods (though sometimes indeed insufficient) of expressing the relative proportions of these parts, is by means of the facial line which has been already described. This angle is most open, or approaches most nearly to a right angle in the human subject; it becomes constantly more acute, as we descend in the scale from man; and in several birds, reptiles, and fishes, it is lost altogether, as the cranium and face are completely on a level. The idea of stupidity is associated, even by the vulgar, with the elongation of the snout: hence the crane and snipe have become proverbial. On the contrary, when the facial line is elevated by any cause which does not increase the capacity of the cranium, as in the elephant and owl, by the cells which separate the two tables, the animal acquires a particular air of intelligence, and gains the credit of qualities which he does not in reality possess. Hence the latter animal has been selected as the emblem of the goddess of wisdom. The invaluable remains of Grecian art shew that the ancients were well acquainted with these circumstances: they were aware that an elevated facial line formed one of the grand characters of beauty, and indicated a noble and generous nature. Hence they have extended the facial angle to 90 degrees in the representation of men, on whom they wished to bestow an august character. And in the representations of

their gods and heroes they have even carried it beyond a right angle, and made it 100°.

It must, however, be allowed, that the facial angle is of chief importance in its application to the cranium of the human subject, and of the quadrumana; as various circumstances affect the conclusions which would result from employing it in other classes of mammalia. Thus in the carnivorous, and some of the ruminating animals; in the pig, and particularly in the elephant, the great size of the frontal sinuses produces an undue elevation of the facial line. In many of the rodentia, as the hare, &c. the nose occupies so large a space, that the cranium is thrown quite back, and presents no point on a front view, from which this line can be drawn.

The following are the angles formed by drawing a line along the floor of the nostrils, and intersecting it by another, which touches the anterior margin of the upper alveoli, and the convexity of the cranium (whether the latter point be concealed by the face or no);

European infant	90°
——— adult	85
Adult negro	70
Orang-outang	67
Long-tailed monkies	65
Baboons	40 to 30
Pole-cat	31
Pug dog	35
Mastiff; the line passing along the outer surface of the skull	41
Ditto; inner ditto	30
Leopard; inner surface	28
Hare	30
Ram	30
Horse	23
Porpoise	25

In the third and fourth tables of Cuvier's "Tableau Elementaire de l'Histoire Naturelle," the crania of several mammalia are represented in profile, so as to afford a sufficient general notion of the varieties in the facial angle. A similar comparative view, in one plate, is given by White, in his account of the "Regular Gradation," &c. from the work of Camper.

A vertical section of the head, in the longitudinal direction, shews us more completely the relative proportions of the cranium and face. In the European, the area of the section of the cranium is four times as large as that of the face; the lower jaw not being included. The proportion of the face is somewhat larger in the negro: and it increases again in the orang-outang. The area of the cranium is about double that of the face in the monkeys; in the baboons, and in most of the carnivorous mammalia, the two parts are nearly equal. The face exceeds the cranium in most of the other classes. Among the rodentia, the hare and marmot have it one-third larger; in the porcupine and the ruminantia, the area of the face is about double that of the cranium; nearly triple in the hippopotamus; and almost four times as large in the horse. In reptiles and fishes the cranium forms a very inconsiderable portion of the section of the head, although it is considerably larger than the brain which it contains.

The outline of the face, when viewed in such a section as we have just mentioned, forms in the human subject a triangle; the longest side of which is the line of junction between the cranium and face. This extends obliquely, backwards and downwards, from the root of the nose towards the foramen occipitale. The front of the face, or the anterior line of the triangle, is the shortest of the three. The face is so much elongated, even in the simiæ, that the line of junction of the cranium and face is the shortest side of the triangle; and the anterior one the longest. These proportions become still more considerable in other mammalia.

The upper jaw-bones of other mammalia do not, as in man, touch each other under the nose, and contain all the upper teeth; but they are separated by a peculiar, single, or double intermaxillary bone, which is in a manner locked between the former, and holds the incisor teeth of such animals as are provided with these teeth. It exists also in the pecora, which have no incisor teeth in the upper jaw; as well as in such genera as have no incisor teeth at all; *viz.* the duck-billed animal and the armadillo. It is even found in those mammalia which are wholly destitute of teeth; as the anteater and the proper whales. It is joined to the neighbouring bones by sutures, which run exteriorly by the side of the nose and snout, and which pass, towards the palate, close to the foramina incisiva. Its form and magnitude vary surprisingly in several orders and genera of mammalia. It is small in many feræ; as also in the walrus. In the glires it is remarkably large, on account of the immense size of their incisor teeth.

In human crania, at least those of the fœtus and young children, there is a small

transverse slit near the foramen incisivum, of which Fallopius gave the following accurate account in the year 1561: " I find this division to be rather a slit than a suture, since it does not separate one bone from the other, nor does it appear exteriorly, nor join two bones, which is the office of sutures." " Obs. Anat."

Hence I was much surprised to find Vicq D'Azyr in 1780, discover in this point an unexpected resemblance between the cranium of the human subject, and of quadrupeds. " Mem. de l'Acad. des Sc. 1780.

In the celebrated dispute of the 16th century, whether Galen's osteology was derived from the skeleton of man or the ape, Ingrassias argued for the latter side of the question from Galen's having ascribed an intermaxillary bone to the human subject. And the same author, in his classical " Commentarii in Galeni Librum de Ossibus," Panorm, 1603, fol. particularly points out the parts, " where Galen, led astray by the dissection of apes, deviates from the true construction of the human body."

In mammalia, which have horns, these parts grow on particular processes of certain bones of the cranium. In the one-horned rhinoceros, they adhere to a rough and slightly elevated surface of the vast nasal bone. The front horn of the two-horned species has a similar attachment; the posterior rests on the os frontis, as those of the horned pecora do. Two kinds of structure are observed in the latter: there are either proper horns, as in the genera of the ox, goat, and antelope; or bony productions, as in the genus cervus, which includes animals of the deer kind: these are also called horns in English, or sometimes antlers; in French, bois de cerf. In the former, the external table of the frontal bones is elongated into a process, which contains a continuation of the frontal sinuses, except in the antelope. Its external vascular surface secretes the horn, which covers this process like a sheath. In the stag kind (in the male only in most genera), the frontal bone forms a short flattened prominence, from which the proper antler immediately shoots forth. It is renewed every year, and is covered, during the time of its growth, with a hairy and very vascular skin.

Castration, or any essential injury of the organs of generation, impedes the growth, alters the form, or interrupts the renewal of the horns.

The word horn, which is frequently applied in English to the antlers of the deer kind, as well as to the real horns of other genera, would lead to a very erroneous notion on this subject. The antler is a real bone; it is formed in the same manner, and consists of the same elements as other bones; its structure is also the same.

It adheres to the frontal bone by its basis; and the substance of the two parts being consolidated together, no distinction can be traced, when the antler is completely organized. But the skin of the forehead terminates at its basis, which is marked by an irregular projecting bony circle; and there is neither skin nor periosteum on the rest of it. The time of its remaining on the head is one year: as the period of its fall approaches, a reddish mark of separation is observed between the process of the frontal bone and the antler. This becomes more and more distinctly marked, until the connection is entirely destroyed.

The skin of the forehead extends over the process of the frontal bone when the antler has fallen: at the period of its regeneration, a tubercle arises from this process, and takes the form of the future antler, being still covered by a prolongation of the skin. The structure of the part at this time is soft and cartilaginous; it is immediately invested by a true periosteum containing large and numerous vessels, which penetrate the cartilage in every direction, and by the gradual deposition of ossific matter convert it into a perfect bone.

The vessels pass through openings in the projecting bony circle at the base of the antler: the formation of this part, proceeding in the same ratio with that of the rest, these openings are contracted, and the vessels are thereby pressed until a complete obstruction ensues. The skin and periosteum then perish, become dry and fall off; the surface of the antler remaining uncovered. At the stated period it falls off, to be again produced, always increasing in size.

The skeleton of quadrupeds deviates more from that of man, in the form of the lower jaw bone, than in any other part. This difference consists chiefly in the want of a prominent chin; that peculiar characteristic of the human countenance, which exists in every race of mankind, and is found in no other instance whatever. Man has also the shortest lower jaw in comparison with the cranium; the elephant, perhaps, approaching the nearest to him in this character. The same bone is further distinguished by the peculiar form and direc-

tion of its condyle. The articulation of these processes varies according to the structure of the masticating organs. They are both situated in the same straight horizontal line in the feræ; their form is cylindrical; and they are completely locked in an elongated glenoid cavity, whose margins are so extended, before and behind the condyle, that all rotatory motions are rendered impossible, and hinge-like movements only allowed. This structure is most strikingly exemplified in the badger, where the cylindrical condyles are so closely embraced by the margins of the articular cavity, that the lower jaw (at least in the adult animal) is still retained in its situation, after the soft parts have been entirely removed by maceration. In many herbivorous animals (in the most extensive sense of the term) these condyles are really rounded eminences; *viz.* in the elephant and beaver. Their surface is flattened in the pecora, which have also the lower jaw narrower than the upper, so that the two sets of teeth do not meet together when the mouth is shut, but are brought into contact by the free lateral motion which takes place in rumination.

As the motions of the lower jaw must be materially influenced by the form of its condyles, and by the manner in which those processes are connected to the articular cavity of the temporal bone; we shall find, as might have been expected, a close relation between these circumstances, and the kind of food by which an animal is nourished. Thus, the lower jaw of the carnivora can only move upwards and downwards, and is completely incapable of that horizontal motion which constitutes genuine mastication. Hence these animals cut and tear their food in a rude and coarse manner, and swallow it in large portions, which are afterwards reduced by the solvent properties of the gastric juice. Such mammalia, on the contrary, as live on vegetables, have, in addition to this motion, a power of moving the lower jaw backwards and forwards, and to either side, so as to produce a grinding effect, which is necessary for bruising and triturating grass, and for pulverising and comminuting grains. In all these, therefore, the form of the condyle, and of its articular cavity, allows of free motion in almost every direction. The teeth may be compared, in the former case, to scissars; in the latter, to the stones of a mill.

THE TEETH.

The jaws of the mammalia, with a very few exceptions, contain teeth. The proper whales (balæna), the pangolin (manis), and the American ant-eaters are the only genera entirely destitute of these organs.

Animals of the genus balæna (the proper whales) have, instead of teeth, the peculiar substance called whalebone, covering the palatine surface of the upper jaw: this resembles in its composition hair, horn, and such matters.

The lower surface of the upper jaw forms two inclined planes, which may be compared to the roof of a house reversed; but the two surfaces are concave. Both these are covered with plates of the whalebone, placed across the jaws, and descending vertically into the mouth. They are parallel to each other, and exist to the number of two or three hundred on each of the surfaces. They are connected to the bone by the intervention of a white ligamentous substance, from which they grow; but their opposite edge, which is turned towards the cavity of the mouth, has its texture loosened into a kind of fringe, composed of long and slender fibres of the horny substance, which therefore covers the whole surface of the jaw. This structure probably serves the animal in retaining and confining the mollusca, which constitute its food.

The teeth of the ornithorhynchus paradoxus and hystrix deviate very considerably from those of other mammalia. In the former animal there is one on each side of the two jaws: it is oblong, flattened on its surface, and consists of a horny substance adhering to the gum. There are likewise two horny processes on the back of the tongue: these point forwards, and are supposed by Mr. Home to prevent the food from passing into the fauces before it has been sufficiently masticated. In the ornithorhynchus hystrix there are six transverse rows of pointed horny processes at the back of the palate, and about twenty similar horny teeth on the corresponding part of the tongue.

The teeth of the human subject seem to be designed for the single purpose of mastication, and hence an erroneous conclusion might be drawn, that they serve the same office in other animals. Many exceptions must, however, be made to this general rule. Some mammalia, which have teeth for the office of mastication, have others, which can only be considered as weapons of offence and defence; *viz.* the tusks of the elephant, hippopotamus, walrus, and manati. The large and long canine teeth of the carnivora, as the lion, tiger, dog, cat,

&c. not only serve as natural weapons to the animal, but enable it to seize and hold its prey, and assist in the rude laceration which the food undergoes previous to deglutition. The seal, the porpoise, and other cetacea, as the cachalot, have all the teeth of one and the same form, and that obviously not calculated for mastication. They can only assist in securing the prey which forms the animal's food.

As the number and arrangement of the teeth was made by Linnæus the basis of his classification of animals, it may be worth while to mention, that this anatomist gives the name of primores to the front, or incisor teeth; and of laniarii to the canine or cuspidati. The term of tusks is applied to such teeth as extend out of the cavity of the mouth.

Certain classes of the teeth are entirely wanting in some orders, classes, and genera of quadrupeds; and in other instances, the different descriptions of teeth, particularly the canine and molares, are separated by considerable intervals. There is no animal in which these parts are of such equal height and such uniform arrangement as in man.

All the three kinds of teeth are found in the quadrumana, the carnivora, the pachydermata (excepting the two-horned rhinoceros and elephant), the horse, and those ruminating animals which have no horns.

Cuvier states, that the teeth of an animal, whose bones are found in a fossil state, resemble those of man, in being arranged in a continued and unbroken series.

In the simiæ, carnivora, and all such as have canines longer than the other teeth, there is at least one vacancy in each jaw, for lodging the cuspidatus of the opposite jaw. There is a vacancy behind each canine in the bear.

The horned ruminating animals not only want entirely the upper incisors, but they are also destitute of cuspidati, except the stag, which has rudiments of these teeth; and the musk (moschus moschifer) where they are very long, and curved in the upper jaw.

Between the incisors and grinders of the horse a very large vacancy is left, in the middle of which a small canine tooth, termed the tush, is found in the male animal; but very rarely in the female.

The elephant has grinders and two tusks in the upper jaw; but the former only in the lower. The immense tusks belong properly to the male animal: as they are so small in the female, generally speaking, as not to pass the margin of the lip. (Corse in Phil. Trans. 1799, part 2. p. 208.)

The sloths have grinding and canine teeth, without incisors. The dolphin and porpoise have small conical teeth, all of one size and shape, arranged in a continued line throughout the alveolar margin of both jaws. The cachalot (physeter macrocephalus) has these in the lower jaw only. The teeth of the seal are all of one form, *viz.* that of the canine kind: conical and pointed.

The narwhal has no other teeth than the two long tusks implanted in its os intermaxillare; of which one is so frequently wanting.

The structure of the incisor teeth, in the rodentia, deserves attention on several accounts. They are covered by enamel only on their anterior or convex surface, and the same circumstance holds good with respect to the tusks of the hippopotamus. Hence as the bone wears down much faster than this harder covering, the end of the tooth always constitutes a sharp cutting edge, which renders it very deserving of the name of an incisor tooth.

This partial covering of enamel refutes, as Blake has observed (" Essay on the Structure, &c. of the Teeth," p. 212), the opinion that the enamel is formed by the process of crystallization.

The incisor teeth of these animals are used in cutting and gnawing the harder vegetable substances; for which their abovementioned sharp edge renders them particularly well adapted. Hence Cuvier has arranged these animals in a particular order by the name of rodentia, or the gnawers. As this employment subjects the teeth to immense friction and mechanical attrition, they wear away very rapidly, and would soon be consumed, if they did not possess a power of growth, by which this loss is recompenced.

These teeth, which are very deeply imbedded in the jaw, are hollow internally, just like a human tooth which is not yet completely formed. Their cavity is filled with a vascular pulp, similar to that on which the bone of a tooth is formed; this makes a constant addition of new substance on the interior of the tooth, which advances to supply the part worn down. The covering of enamel extends over that part of the tooth which is contained in the jaw, as we might naturally expect: for this must be protruded at some future period to supply the loss of the anterior portion. Although these teeth are very deeply implanted in the

maxillary bones, they can hardly be said to possess a fang or root; for the form of the part is the same throughout; the covering of enamel is likewise continued; and that part, which at one period is contained in the jaw, and would form the fang, is afterwards protruded to constitute the body of the tooth.

The constant growth of these teeth therefore proceeds in the same manner, and is effected on the same principles as the original formation of any tooth; and can by no means furnish an argument for the existence of vessels in the substance of the part.

We cannot help being struck with the great size of these teeth, compared with the others of the same animal, or even with the bulk of the animal. Their length in the lower jaw nearly equals that of the jaw itself, although a small proportion only of this length appears through the gum. They represent the segment of a circle; and are contained in a canal of the bone, which descends under the sockets of the grinders, and then mounts up, in some instances, to the root of the coronoid process: hence, although their anterior cutting edge is in the front of the mouth, the posterior extremity is behind all the grinding teeth. No animal exhibits this structure better than the rat. The beaver also affords a good specimen of it on a larger scale. It has been drawn in this animal by Blake, ("Essay on the structure, &c. of the teeth.") The tooth does not extend so far in the upper jaw; it is there implanted in the intermaxillary bone, and terminates over the first grinder.

The observations which have been made respecting the constant growth of the incisor teeth of the glires, will apply also to the tusks of the elephant. These are hollow internally, through the greater part of their length, and the cavity contains a vascular pulp, which makes constant additions of successive layers, as the tusk is worn down. One of the elephants at Exeter Change is said to have nearly bled to death from a fracture of the tusk, and consequent laceration of the vessels of the pulp. The tusks of the hippopotamus, and probably all other teeth of this description grow in the same manner. Farther and more accurate observation may hereafter shew, that the same mode of growth obtains also in other classes of teeth, when they are exposed to great friction. Something similar may certainly be observed in the grinders of the horse. The tooth is not finished when it cuts the gum: the lower part of its body is completed, while the upper part is worn away in mastication; and the proper fang is not added till long after. Hence we can never get one of these teeth in a perfect state, for if the part out of the gum is complete, the rest of the body is imperfect; and there are no fangs: on the contrary, when the fangs are formed, much of the body has been worn away in mastication. Blake also asserts, that this structure is found in the grinders of the beaver, (p. 99.)

The narwhal is particularly distinguished by its long and spiral tusk. This animal is found so constantly with only one tusk, that it has been called in common language, the sea-unicorn; and Linnæus has even given it a similar appellation, that of monodon. Yet there can be no doubt that it possesses originally two of these; one in either jaw bone: and that which is wanting must have been lost by some accidental circumstance, as we can easily suppose, ("Shaw's Zoology", vol. ii. p. 473.) These tusks often equal in length that of the animal's body; which may be 18 feet or more: yet they are always slender.

In many baboons, and most particularly in the larger predacious mammalia, the canine teeth are of a terrific size; in the latter animals, the whole profile of the anterior part of the cranium, forms a continuous line with these teeth; which is very visible in the tiger. The canine tusks of the babiroussa, which are very long, and recurved so as nearly to describe a complete circle, present the most curious structure. Their utility to the animal appears quite obscure, when their length, direction, and smallness are considered.

The distribution of the enamel and bony substance varies in the teeth of different animals, and even in the different orders of teeth in the same animal.

All the teeth of the carnivora, and the incisors of the ruminating animals, have the crown only covered with enamel, as in the human subject. The immense fossil grinders of the animal incognitum, or mammoth, have a similar distribution of this substance.

The grinders of graminivorous quadrupeds, and the incisors also of the horse have processes of enamel, descending into the substance of the tooth. These organs have also in the last-mentioned animals a third component part, differing in appearance from both the others, but resembling the bone more than the enamel. Blake has

distinguished this by the name of crusta petrosa; and Cuvier calls it cement.

The physiological explanation of this difference in structure is a very easy and clear one. The food of the carnivora requires very little comminution before it enters the stomach: hence the form of their grinding teeth is by no means calculated for grinding: and as the articulation of the jaw admits no lateral motion, the molares, of which the lower are overlapped by the upper, can only act like the incisors of other animals. The food of graminivorous quadrupeds are subject to a long process of mastication, before it is exposed to the action of the stomach. The teeth of the animals suffer great attrition during this time, and would be worn down very rapidly but for the enamel, which is intermixed with their substance. As this part is harder than the other constituents of the teeth, it resists the attrition longer, and presents the appearance of prominent ridges on the worn surface, by which the grinding of the food is much facilitated.

The distinction of the three substances is seen better in the tooth of the elephant than in any animal. The best method of displaying it is by making a longitudinal vertical section, and polishing the cut surface. The crusta petrosa will then be distinguished by a greater yellowness and opacity in its colour; and by an uniformity in its appearance, as no laminæ or fibres can be distinguished.

The pulp of a grinding tooth of a graminivorous quadruped is divided into certain conical processes, which are united at their bases. These vary from two to six in the horse and cow. On these the bone of the tooth is formed, as on the single pulp of the human subject, but it is here divided into as many separate shells, as there are processes of the pulp: all of them however inclosed in a common capsule. The ossification commences, as in all teeth, on the points of the pulp, and extends towards the basis: when it has arrived there, the shells unite together; and they also join at their outer margins. Between the processes of the pulp other productions descend from the capsule in a contrary direction; and deposit on the surface of the shells enamel distinguishable by its crystalline appearance, and hence denominated by Blake cortex striatus. When these membranous productions have formed their portions of enamel, they secrete the crusta petrosa within the cavities left between these productions of enamel. The outer surface of the bone of the tooth is covered by enamel, which may be compared to that which invests the crown of a human tooth, except that it is deposited in an irregular waving line, in order to render the surface better calculated for grinding: and the inequalities of this surface of enamel are filled up by crusta petrosa. The exterior enamel, and crusta petrosa, (which may be so named, by way of distinguishing them from the processes within the tooth), are formed by the surface of the capsule.

If then we make a transverse section of a grinding tooth of the horse or cow, the exterior surface will be found to consist of an irregular layer of crusta petrosa: this is succeeded by a waving line of enamel, within which is the proper bone of the tooth. But the substance of the latter is penetrated by two productions of enamel, in the interior of each of which is crusta petrosa.

The crusta petrosa which fills these internal productions of enamel, is sometimes not completely deposited before the tooth cuts the gum: hence cavities are left in the centre of the tooth, which become filled with a dark substance composed of the animal's food, and other foreign matters. This seldom happens to any considerable extent in the grinders of the horse. In the cow and sheep these cavities are constantly filled with the dark adventitious matter; the crusta petrosa being confined to the exterior surface of the tooth, and not existing even there so plentifully as in the horse.

The lower grinders of the horse differ very much in their formation from those of the upper-jaw. Ossification commences in these by four or five points, which increase into as many small shells; yet they unite without any processes of the capsule passing down between to form internal productions of the enamel. That substance is however deposited in a very convoluted manner on the bone of the tooth, so that the same end is attained, as if productions of the cortex striatus had existed in the centre of the part. The crusta petrosa fills up the irregularities of this waving line of enamel. An horizontal section of such a tooth presents the three substances arranged within each other: the crusta petrosa is external; then comes the enamel, which includes nothing but the proper bone of the tooth.

The incisors of the horse have a production of enamel in their centre; but the cavity which this forms, containing no crusta petrosa, is merely filled by the particles of

food, &c. As these processes of enamel descend only to a certain extent in the tooth, they disappear at last from the constant wear of the part in mastication. This is improperly called the filling up of the teeth; and hence a criterion arises of the horse's age.

The grinding teeth of the elephant contain the most complete intermixture of the three substances, and have a greater proportion of crusta petrosa than those of any other animal. The pulp forms a number of broad flat processes, lying parallel to each other, and placed transversely between the inner and outer laminæ of the alveoli. The bone of the tooth is formed on these in separate shells, commencing at their loose extremities, and extending towards the basis, where they are connected together. The capsule sends an equal number of membranous productions; which first cover the bony shells with enamel, and then invests them with crusta petrosa: which latter substance unites and consolidates the different portions. The bony shells vary in number from four to twenty-three, according to the size of the tooth, and the age of the animal: they have been described under the term of denticuli, and have been represented as separate teeth in the first instance. It must however be remembered that they are formed on processes of one single pulp.

When the crusta petrosa is completely deposited, the different denticuli are consolidated together. The bony shells are united at their base to the neighbouring ones; the investments of enamel are joined in like manner: and the intervals are filled with the third substance, which really deserves the name bestowed on it by Cuvier, of cement. The pulp is then elongated for the purpose of forming the roots or fangs of the tooth. From the peculiar mode of dentition of this animal, which will be explained in a subsequent note, the front portion of the tooth has cut the gum, and is employed in mastication, before the back part is completely formed, even before some of the posterior denticuli have been consolidated. The back of the tooth does not appear in the mouth until the anterior part has been worn down even to the fang.

A horizontal section of the elephant's tooth presents a series of narrow bands of bone of the tooth, surrounded by corresponding portions of enamel. Between these are portions of crusta petrosa; and the whole circumference of the section is composed of a thick layer of the same substance.

A vertical section in the longitudinal direction exhibits the processes of bone, upon the different denticuli, running up from the fangs: a vertical layer of enamel is placed before, and another behind each of these. If the tooth is not yet worn by mastication, the two layers of enamel are continuous at the part where the bone terminates in a point; and the front layer of one denticulus is continuous with the back layer of the succeeding one, at the root of the tooth; so that the enamel, ascending on the anterior, and descending on the posterior surface of each denticulus, forms a continued line through the whole tooth. Crusta petrosa intervenes between the ascending and descending portions of the enamel.

As the surface of the tooth is worn down in mastication, the processes of enamel, resisting by their superior hardness, form prominent ridges on the grinding surface, which must adapt it excellently for bruising and comminuting any hard substance.

The grinding bases, when worn sufficiently to expose the enamel, present a very different appearance in the Asiatic and African elephants. The processes of enamel in the former species represent flattened ovals, placed across the tooth. In the latter they form a series of lozenges, which touch each other in the middle of the tooth.

It does not appear that crusta petrosa is an essential part in the grinders of graminivorous animals. For those of the rhinoceros do not possess it, although the enamel descends into their substance, and forms a cavity, which is filled with the food, &c.

Home and Blake likewise state, that it does not exist in the hippopotamus, where there are internal productions of enamel: but Mr. Macartney, the learned and ingenious lecturer on comparative anatomy at St. Bartholomew's Hospital, has found it in small quantity on the exterior surface of the tooth, near its root.

The want of satisfactory observations prevents us from saying much on the change of the teeth, particularly in wild animals. Some erroneous opinions of former times, as, for instance, that the domesticated pig changes its teeth, and that the wild animal does not, hardly require an express contradiction in the present day. There is no animal of the class Mammalia, where the first appearance and subsequent removal of the deciduous teeth take place at so late a period of life as in man.

The permament teeth are generally formed in cavities near the roots of the temporary ones; and they succeed to the vacancies left by the discharge of the latter. A different mode of succession obtains, however, in some instances. The adult molares of the human subject are formed in the back of the two jaws, from which situation they advance successively towards the front, in proportion as the maxillary bones are lengthened in that direction. A similar, but much more remarkable species of succession is observed in the grinders of the elephant, where it was ascertained by the labours of Mr. Corse, who has explained and illustrated the subject in a series of beautiful engravings. See "Observations on the different Species of Asiatic Elephants, and their Mode of Dentition," Phil. Trans. 1799, Part II.

We never see more than one grinder, and part of another, through the gum in this animal. The anterior one is gradually worn away by mastication: its fangs and alveoli are then absorbed; the posterior tooth coming forwards to supply its place. As this goes through the same stages as the preceding grinder, a third tooth, which was contained in the back of the jaw, appears through the gum, and advances, in proportion as the destruction and absorption of the other proceed. The same process is repeated at least eight times; and each new grinder is larger than that which came before it. The first, or milk grinder, is composed of four transverse plates or denticuli, and cuts the gum soon after birth. The 2d, which has eight or nine plates, has completely appeared at the age of two years. The 3d, formed of twelve or thirteen, at six years. From the 4th to the 8th grinder the number of plates varies from fifteen to twenty-three, which is the largest hitherto ascertained. The exact age at which each of these is completed, has not yet been made out. But it appears, that every new one takes at least a year more for its formation than its predecessor.

From the gradual manner in which the tooth advances, it is manifest, that a small portion of it only can penetrate the gum at once. A grinder, consisting of twelve or fourteen plates, has two or three of these through the gum, whilst the others are imbedded in the jaw. The formation of the tooth is complete, therefore, first, at its anterior part, which is employed in mastication, while the back part is very incomplete; as the succeeding laminæ advance through the gum, their formation is successively perfected. But the posterior layers of the tooth are not employed in mastication, until the anterior ones have been worn down to the very fang, which begins to be absorbed. One of these grinders can never, therefore, be procured in a perfect state: for if its anterior part has not been at all worn, the back is not completely formed, and the fangs in particular are wanting; while the structure of the back of the tooth is not completed, until the anterior portion has disappeared.

A similar kind of succession, but to a less extent, has been ascertained by Mr. Home, in the teeth of the sus Æthiopicus. "Observations on the Structure of the Teeth of graminivorous Quadrupeds; particularly those of the Elephant and sus Æthiopicus," Phil. Trans. 1799, Part II.

The researches of the same gentleman have also proved it to exist in the wild boar to a certain degree; and have rendered it probable, that it occurred likewise in the animal incognitum (mammoth). "Observations on the Structure and Mode of Growth of the Wild Boar and animal Incognitum." Phil. Trans. 1801, Part II.

It is remarkable, that the number of cervical vertebræ in the mammalia should be constantly seven, although the animals of this class differ so much in the length of the neck. A single exception occurs in the three-toed sloth, which has nine.

The lumbar vertebræ vary much in number; the elephant has three, the camel seven, the horse six, and the ass five. Mules have generally six. The os coccygis is prolonged so as to form the tail of quadrupeds.

The cavity of the pelvis is so narrow in the mole, that it cannot hold the parts of generation, and the neighbouring viscera, which lie, therefore, externally to the ossa pubis.

In the kangaroo, and in other marsupial animals, the anterior margin of the ossa pubis is furnished with a peculiar pair of small bones for supporting the abdominal pouch of the female.

Cetaceous animals, having no hind feet, have, consequently, no pelvis: but there is a pair of small bones at the lower part of the belly, which may be compared to the ossa pubis.

In a very few mammalia, as some bats and armadillos, there is a pair of ribs less than in man; but in most of the class these bones are more numerous. The horse has

18, the elephant 19, and the two-toed sloth 23 pairs. The sternum is generally cylindrical and jointed.

BONES OF THE UPPER EXTREMITY.

We may assert, as a general observation, that the four component parts of the upper extremity, *viz.* the shoulder, arm, fore-arm, and hand, can be clearly shewn to exist in the anterior extremities of all mammalia; however dissimilar they may appear to each other on a superficial inspection, and however widely they may seem to deviate from the human structure.

Whenever an animal of one class resembles those of a different order in the form and use of any part, we may be assured that this resemblance is only in externals and that it does not affect the number and arrangement of the bones. Thus the bat has a kind of wings; but an attentive examination will prove, that these are really hands, with the phalanges of the fingers elongated. The dolphin, porpoise, and other cetacea, seem to possess fins, consisting of a single piece. But we find, under the integuments of the fin-like members, all the bones of an anterior extremity, flattened in their form, and hardly susceptible of any motion on each other. We can recognise very clearly the scapula, humerus, bones of the fore-arm, and a hand consisting of five fingers: the same parts, in short, which form the anterior extremity of other mammalia. See Tyson's "Anatomy of a Porpoise," fig. 10 and 11: also Blasii "Anatomia Animalium," tab. 51, fig. 3, 4.

The fore-feet of the sea-otter, seal, walrus, and manati, form the connecting link between the anterior extremities of other mammalia, and the pectoral fins of the whale kind. The bones are so covered and connected by integuments, as to constitute a part, adapted for the purposes of swimming: but they are much more developed than in the latter animals, and have free motion on each other.

The cold-blooded quadrupeds bear great analogy in the four component parts, and in the general structure of their anterior extremities, to the warm-blooded ones. See Caldesi's "Observations on the Turtle," tab. 3, fig. 1, 4, 5.

The bones of the wing of birds have a considerable and unexpected resemblance to those of the fore-feet of the mammalia. And the fin-like anterior member of the penguin contains, within the integuments, the same bones as the wings of other birds.

The clavicle supports the anterior extremity, and maintains the shoulder at its proper distance from the front of the trunk. It exists, therefore, in all such animals as make much use of these members, whether for the purpose of climbing, digging, swimming, or flying. It has, indeed, been supposed to be confined to Linnæus's order Primates (in which he includes man, the quadrumanous animals, and bats). It will be found in the squirrel and beaver, who use their front extremities for the purpose of holding objects, rather than for that of supporting the body: in the mole, who employs them for digging, &c. &c. Many other animals have in its place an analogous small bone, merely connected to the muscles, and called, by Vicq d'Azyr, os claviculare, to distinguish it from the more perfect clavicle. This is the case with most of the feræ, and some glires. It does not exist, on the contrary, in such as use their fore-feet merely for the purpose of progression; since these limbs must be brought more forwards on the chest, that they may support that part, by being placed perpendicularly under it. In the genera, which hold an intermediate rank between these; which do not enjoy such an extensive utility of the fore-feet as the first division of animals; and are not so limited in their employment as the second, the clavicular bones, or imperfect clavicles exist.

In ruminating animals, and in the horse, the metacarpus consists of a single bone, called the cannon bone, which is very long when compared with that of man. The humerus becomes shorter, in proportion as the metacarpus is elongated: so that in animals which have a cannon bone, the os humeri hardly extends beyond the trunk. Hence the mistakes which are made in common language by calling the carpus of the horse his fore-knee, &c.

The radius forms the chief bone of the fore-arm in the mammalia, generally speaking; the ulna is a small slender bone, terminating short of the wrist in a point, and often consolidated with the radius, as in the horse and ruminating animals. A few genera, which have great and free use of their anterior extremity, have the power of pronation and supination. But this power diminishes, as the fore-feet are used more for the purpose of supporting the body in standing, and in progression. In this case, indeed, the extremity may be said to be constantly in the prone position, as the back of the carpus and toes is turned forwards.

The lower end of the ulna is larger than that of the radius in the elephant; but this circumstance occurs in no other instance.

The radius and ulna exist in the seal, manati, and whales, but in a flattened form.

Several genera of mammalia possess a hand; but it is much less complete, and consequently less useful than that of the human subject, which well deserves the name bestowed on it by Aristotle, of the organ of all organs. The great superiority of that most perfect instrument, the human hand, arises from the size and strength of the thumb, which can be brought into a state of opposition to the fingers, and is hence of the greatest use in grasping spherical bodies, in taking up any object in the hand, in giving us a firm hold on whatever we seize; in short, in a thousand offices, which occur every moment of our lives, and which either could not be accomplished at all, if the thumb were absent, or would require the concurrence of both hands, instead of being done by one only. Hence it has been justly described by Albinus as a second hand, "manus parva majori adjutrix," de sceleto, p. 465.

All the simiæ possess hands: but even in those, which may be most justly stiled anthropomorphous, the thumb is small, short, and weak; and the other fingers elongated and slender. In others, as some of the cercopitheci, there is no thumb, or at least it is concealed under the integuments; but these animals have a kind of fore paw, which is of some use in seizing and carrying their food to the mouth, in climbing, &c. like that of the squirrel. The genus lemur has also a separate thumb. Other animals, which have fingers sufficiently long and moveable for seizing and grasping objects, are obliged, by the want of a separate thumb, to hold them by means of the two fore-paws; as the squirrel, rat, opossum, &c. Those, which are moreover obliged to rest their body on the fore-feet, as the dog and cat, can only hold objects by fixing them between the paw and the ground. Lastly, such as have the fingers united by the integuments, or enclosed in hoofs, lose all power of prehension.

The metacarpus is elongated in those animals, where the toe only touches the ground in standing or walking; and constitutes the part, which is commonly called the fore-leg; as the carpus is termed the knee.

The number of metacarpal bones is the same with that of the fingers or fore-toes: except in the ruminating animals. Even in these there are two distinct metacarpal bones, lying close together before birth: the opposed surfaces first become thinner, then are perforated by several openings, and at last disappear; so that the adult animal has a single cannon bone, possessing a common medullary cavity internally, and marked on the outside with a slight groove at the place of the original separation. There is therefore but one metacarpal bone in the adult for the two toes. The structure of the metatarsus is the same.

The single finger or fore-toe of the horse is composed of the usual three phalanges; the first, which is articulated to the cannon, is called the pastern; the 2d is the coronet; and the 3d the os basis or coffin bone; on which the hoof rests. There are also two sesamoid bones at the back of the pastern joint; and an additional part called the shuttle-bone connected to the coffin.

In those animals, which have five toes, as the carnivora, &c. that which lies on the radial side of the extremity, and is therefore analogous to the thumb, is parallel with the others; and the animal consequently has not the power of grasping any object. The last phalanx in these supports the nail of the animal; and sends a process into its cavity. These parts are so connected that the nail is naturally turned upwards, and not towards the ground; so that its point is not injured in the motions of the animal. The phalanx must be bent in order to point the nail forwards or downwards.

The order of rodentia have generally five toes: that which corresponds to the thumb being the shortest.

The elephant has five complete toes; but they are almost concealed by the thick skin.

The pig has four toes; two larger ones, which touch the ground; and two smaller behind these, which do not reach so far. There is also a bone, which seems to be the rudiment of a thumb.

The phalanges of the cetacea are flattened; not moveable, and joined together in the fin.

BONES OF THE LOWER EXTREMITY.

The length of the femur depends on that of the metatarsus; and it bears an inverse ratio to the length of that part.

Hence it is very short in the horse, cow, &c. where the same mistakes are commonly

committed in naming the parts, as in the anterior extremity.

The proportions of the thigh and leg vary in different animals. The latter part exceeds the former in the human subject; and the same remark may be made respecting the arm and fore-arm. These parts are nearly of the same length in the orang-outang. Some persons have affirmed that the negro forms a connecting link between the European and the orang-outang in these respects. (White on the regular Gradation in Man and Animals, &c.) In some other simiæ the leg and fore-arm exceed the thigh and arm. In other animals, although there are some varieties, the leg is generally longer than the thigh.

The fibula is consolidated to the tibia at its lower end in the mole and rat. It only exists as a small styloid bone in the horse, and becomes anchylosed to the tibia in an old animal.

The structure of the metatarsus in the ruminating animals, and the horse, is the same with that of the metacarpus.

The tarsus of the horse is composed of six bones; and is the part known in common language by the name of the hock.

Animals of the genus simia and lemur, instead of having a great toe placed parallel with the others, are furnished with a real thumb: i. e. a part capable of being opposed to the other toes. Hence these animals can neither be called biped nor quadruped, but are really quadrumanous or fourhanded. They are not destined to go either on two or four extremities, but to live in trees, since their four prehensile members enable them to climb with the greatest facility. So that Cuvier has denominated them "les grimpeurs par excellence." (Leçons d' Anat. Comp. vol. i. p. 493.) The prehensile tail of several species is a further assistance in this way of life. The opossum, and others of the genus didelphis, have a similar structure with the quadrumana; and it answers the same purpose. Here however there is a separate thumb on the posterior extremity only, whence Cuvier calls them pedimanes.

Man is the only animal in which the whole surface of the foot rests on the ground: and this circumstance arises from the erect stature, which belongs exclusively to him. In the quadrumana, in the bear, hedgehog, and shrew, (which are called by Cuvier plantigrades), the os calcis does not touch the ground.

The heel of a species of bear belonging to this country, *viz.* the badger (ursus meles) is covered with a long fur, which proves that this part cannot rest on the ground; although the structure both of the bones and muscles of the lower extremity of this animal approaches considerably to that of man. The same fact is stated of the bear itself, properly so called, by the Parisian dissectors.

In other animals the body is supported upon the phalanges of the toes, as in the dog and cat; in the horse and ruminating animals no part touches the ground but the last phalanx. Here the elongation of the metatarsus removes the os calcis to such a distance from the toe, that it is placed midway between the trunk and hoof.

SKELETON OF BIRDS.

The skull, which in the adult has no sutures, is articulated to the spine by a single rounded condyle. This structure gives the head a great freedom of motion, particularly in the horizontal direction. It enables the bird to place its bill between the wings when asleep; a situation in which none of the mammalia can place the snout.

The lower jaw is articulated to the cranium by means of a square bone on each side, called os quadratum. The superior mandible, which is completely immoveable in mammalia, has, with a few exceptions, more or less motion in birds. It either constitutes a particular bone, distinct from the rest of the cranium, to which it is articulated, as in the psittaci (birds of the parrot kind); or it is connected into one piece with the cranium, by means of yielding and elastic bony plates; as is the case with birds in general. It is quite immoveable in a very few instances, as the tetrao urogallus (cock of the woods) and the rhinoceros bird.

The jaws are entirely destitute of teeth. The bill may be considered, in some degree, as supplying the place of teeth; yet, as none of these animals masticate their food, but swallow it whole, the bill can only be compared to the incisors of such animals as use them for seizing and procuring their food.

It consists of a horny fibrous matter, similar to that of the nail, or of proper horns; and is moulded to the shape of the bones, which constitute the two mandibles, being formed by a soft vascular substance, covering these bones. Its form and structure are as intimately connected with the habits and general character of the animal,

as those of the teeth are in the mammalia. Hence an enumeration of its different figures and consistence belongs properly to the department of natural history, where it forms the foundation of classific distinctions.

The accipitres, or rapacious birds, have it very hard, hooked at the end, and furnished with a process on either side; calculated, therefore, in all respects, for seizing and lacerating their prey. Those of the parrot kind have it also hard, for bruising the firmer vegetable fruits; and the woodpecker, nuthatch, &c. for penetrating the bark of trees.

Those birds, which take a softer kind of food, and which require a sense of feeling in the part, for distinguishing their food in mud, water, &c. have it approaching to the softness of skin. Such are the duck, snipe, woodcock, &c.

In several classes, particularly the accipitres and gallinæ, the base of the bill is covered with a soft skin, called the cire, of unknown use.

The cervical vertebræ of birds are very numerous, and have a very free motion on each other. This great mobility of the neck enables the animal to touch every point of its body with the bill; and thus supplies the want of the prehensile faculty of the anterior extremity. The sternum is prolonged below into a vertical process (crista) for the attachment of the strong pectoral muscles which are the chief agents in the act of flying. In the male wild swan (anas cygnus) and in some species of the genus ardea, as the crane, this part forms a peculiar cavity for the reception of a considerable portion of the trachea. The crista is entirely wanting in the ostrich and cassowary; where the sternum presents, on its anterior or under surface, an uniform convexity, and this peculiarity of structure is accounted for by observing that these birds have not the power of flying.

The wings are connected to the trunk by means of three remarkable bones. The clavicles, which are always strong, constitute straight cylindrical bones articulated to the sides of the front of the sternum, and extending straight forwards. Their anterior extremities are connected to the sternum, by means of a bone peculiar to birds, *viz.* the fork-like bone, or, as it is more commonly termed, the merrythought. (Furcula, in French la lunette or fourchette.) The scapula, which is flattened in form, but elongated, extends backwards from the front of the clavicle, parallel to the spine. The point of the fork-like bone is joined to the most prominent part of the keel of the sternum; and the extremities of its two branches are tied to the humeral ends of the clavicles, and the front of the scapulæ, just where these bones join each other, and are articulated with the humerus. Hence it serves to keep the wings apart in the rapid motions of flying.

As a general observation, it may be stated that the fork is strong and elastic; and its branches wide, arched, and carried forwards upon the body, in proportion as the bird possesses strength and rapidity of flight; and accordingly the struthious birds (ostrich and cassowary), which are incapable of this mode of progression, have the fork very imperfectly formed. The two branches are very short, and never united in the African ostrich, but are anchylosed with the scapula and clavicle. The cassowary has merely two little processes from the side of the clavicle, which are the rudiments of the branches of the fork. In the New Holland ostrich there are two very small thin bones, which are attached to the anterior edge of the dorsal end of the clavicles by ligament; they are directed upwards towards the neck, where they are fastened to each other by means of a ligament, and have no connection whatever with the sternum.

The bones of the wing may be compared on the whole to those of the upper extremity in man: and consist of an os humeri; two bones of the fore arm; two of the carpus; two, which are generally consolidated together, of the metacarpus; one bone of the thumb, and two fingers.

The stork, and some others of the grallæ, which sleep standing on one foot, possess a curious mechanism for preserving the leg in a state of extension, without any, or at least with little, muscular effort. There arises from the fore-part of the head of the metatarsal bone a round eminence, which passes up between the projections of the pulley, on the anterior part of the end of the tibia. This eminence affords a sufficient degree of resistance to the flexion of the leg, to counteract the effect of the oscillations of the body, and would prove an insurmountable obstruction to the motion of the joint, if there were not a socket, within the upper part of the pulley of the tibia, to receive it when the leg is in the bent position. The lower edge of the socket is prominent and sharp, and presents a sort of barrier to the admission of the eminence, that requires a voluntary muscular exertion of the

bird to overcome, which being accomplished, it slips in with some force, like the end of a dislocated bone.

SKELETON OF THE AMPHIBIA.

Turtles and tortoises have no teeth: but their jaws are covered with a horny substance somewhat resembling the horse's hoof in the mode of its connection with the bone. The cavity containing the brain is extremely small in comparison with the size of the skull. This circumstance is still more remarkable in the crocodile, where, in an individual measuring 13 or 14 feet, this cavity will hardly admit the thumb. The vast muscles of the jaw fill up the sides of the cranium.

The body of the turtle and tortoise is provided with two broad and flattened bony shells, to which the trunk of their skeleton is consolidated.

Frogs and toads have no teeth. In no other animal are the jaws of such immense size, in comparison with the extremely small cavity of the cranium, as in the crocodile. The anterior part of the upper jaw, consists of a large intermaxillary bone; and the lateral portions of the lower maxilla are formed of several pieces joined together. The lower jaw is articulated in a peculiar manner in these animals: it has an articular cavity, in which a condyle of the upper jaw is received.

The condyle resembles, in some measure, the pulley at the inferior extremity of the humerus (the trochlea, or rotula of Albinus); this, at least, is the case in the skull of the alligator.

The old error, of supposing that the upper jaw of the crocodile is moveable, and the lower, on the contrary, incapable of motion, which has been adopted even by such anatomists as Vesalius and Columbus, has perhaps arisen from this peculiar mode of articulation. An examination of the cranium shows, that if the lower jaw remains unmoved, the whole remainder of the skull may be carried backwards and forwards by means of this joint. And such a motion is proportionally easier in the present instance, than in any other animal, both on account of the very great relative size of the lower jaw, as well as from its anomalous mode of articulation. There is, however, no motion of the upper jaw-bone only, upon the bones of the cranium, similar to that which occurs in most birds, serpents, and fishes.

The most surprising singularity in the skeleton of the crocodile consists in an abdominal sternum, which is quite different from the thoracic sternum, and extends from the ensiform cartilage to the pubis, apparently for the purpose of supporting the abdominal viscera.

The serpents have an upper jaw, unconnected with the rest of the skull, and more or less moveable of itself.

We find in their teeth the important and clearly defined difference, which distinguishes the poisonous species of serpents from the much more numerous innoxious tribes.

The latter have, in the upper jaw, four maxillary bones, beset with small teeth, which form two rows, separated by a considerable interval from each other. One of these is placed along the front edge of the jaw; the other is found more internally, and is situated longitudinally on either side of the palate.

The external row is wanting in the poisonous species; which have, in their stead, much larger tubular fangs, connected with the poison bladder, and constituting, in reality, bony excretory ducts, which convey the venom into the wound inflicted by the bite of the animal.

It appears, in general, that the number of vertebræ in red-blooded animals, is in an inverse proportion with the size and strength of their external organs of motion. Serpents, therefore, which entirely want these organs, have the most numerous vertebræ; sometimes more than 300.

It may be observed in confirmation of this remark, that the number of vertebræ is very great in fishes of an elongated form; *viz.* in the eel, which has above one hundred. The porpoise, which has no organs of motion which deserve mentioning, has between sixty and seventy.

Birds which have such vast power of locomotion by means of their wings, have very few vertebræ, if we consider the anchylosed ones as forming a single piece. And the frog, with its immense hind extremities, has a very short spine, consisting of still fewer pieces.

We should naturally conclude, from observing the great diversity in the general form of fishes, that the structure of their skeleton must be equally various. They agree together, however, on the whole, in having a spine, which extends from the cranium to the tail-fin; and in having the other fins, particularly those of the thorax and abdomen, articulated with peculiar bones,

destined to that purpose. They have in general many more bones unconnected with the rest of the skeleton, than the animals of the preceding classes.

The cranium in several cartilaginous fishes, (in the skate for instance) has a very simple structure, consisting chiefly of one large piece. In the bony fishes, on the contrary, its component parts are very numerous; amounting to 80 in the head of the perch. Most of the latter have a more or less moveable under-jaw.

Great variety in the structure of the teeth is observed in this class. Some genera, as the sturgeon, are toothless. Their jaws, which are distinct from the cranium, form a moveable part, capable of being thrust forwards from the mouth, and again retracted.

Those fishes which possess teeth, differ very much in the form, number, and position of these organs. Some species of sparus, (as the S. probato-cephalus) have front teeth almost like those of man; they are provided with fangs, which are contained in alveoli. In many genera of fishes, the teeth are formed by processes of the jaw-bones covered with a crust of enamel. In most of the sharks, the mouth is furnished with very numerous teeth for the supply of such as may be lost. The white shark has more than two hundred, lying on each other in rows, almost like the leaves of an artichoke. Those only which form the front row have a perpendicular direction, and are completely uncovered. Those of the subsequent rows are, on the contrary, smaller; have their points turned backwards, and are covered with a kind of gum. These come through the covering substance, and pass forward when any teeth of the front row are lost. It will be understood from this description, that the teeth in question cannot have any fangs.

The saw-fish only (squalus pristis) has teeth implanted in the bone on both sides of the sword-shaped organ, with which its head is armed.

In some fishes the palate, in others the bone of the tongue (as in the frog-fish), in others (as in several of the ray-kind), the aperture of the mouth forms a continuous surface of tooth.

MOUTH, ŒSOPHAGUS, AND STOMACH.

We have already shown the most important circumstances relating to the mouth. Many species of the genus simia, as well as the hamster, (marmota cricetus) and some similar species of the marmot, are provided with cheek pouches, in which the former, who live on trees, place small quantities of food as a reserve: the latter employ these bags to convey their winter provision to their burrows.

The peculiar glandular and moveable bag, (bursa faucium) which is placed behind the palate, has hitherto been only observed in the camels of the old world: and it probably serves to lubricate the throat of these animals in their abode in the dry sandy deserts which they inhabit.

The œsophagus of quadrupeds is distinguished from that of the human subject by possessing two rows of muscular fibres, which pursue a spiral course, and decussate each other. In those carnivorous animals which swallow voraciously, as the wolf, it is very large; on the contrary, in many of the larger herbivora, and particularly in such as ruminate, its coats are proportionally stronger.

No mammalia possess an uvula, except man and the simia.

In some herbivora the stomach has an uniform appearance externally; but it is divided into two portions internally, either by a remarkable difference in the two halves of its internal coat, as in the horse, or by a valvular elongation of this membrane, as in several animals of the mouse-kind. This is also the case in the hare and rabbit, where also the food in the two halves of the stomach differs very much in appearance, particularly if the animal has been fed about two hours before death.

In these animals the left half of the stomach is covered with cuticle, while the other portion has the usual villous and secreting surface. The left portion of the cavity may be regarded as a reservoir, from which the food is transmitted to the true digestive organ; and the different states in which the food is found in the two parts of the cavity justify this supposition. Hence these stomachs form a connecting link between those of ruminating animals on one side, and those which have the whole surface villous on the other.

On the whole internal surface of the horse's stomach there are found in vast abundance, particularly in spring, the larvæ of two species of œstrus; *viz.* the œstrus equi (which Linnæus called œstrus bovis, and the œ. hæmorrhoidalis, the true history of which has been elucidated, for the first time in modern days, by that excellent veterinary surgeon Mr. Bracy Clark, in the

"Transactions of the Linnæan Society." vol. 3.

These animals, which are called botts, attach themselves to every part of the stomach, but are in general most numerous about the pylorus; and are sometimes, but much less frequently, found in the intestines. They hang most commonly in clusters, being fixed by the small end to the inner membrane of the stomach, where they adhere by means of two small hooks or tentacula. When removed from the stomach, they will attach themselves to any loose membrane, and even to the skin of the hand; for this purpose they draw back their hooks almost entirely within the skin, till the two points of these hooks come close to each other; they then present them to the membrane, and keeping them parallel till it is pierced through, they expand them in a lateral direction; and afterwards, by bringing the points downwards, or towards themselves, they include a sufficient piece of the membrane with each hook, and thus remain firmly fixed, for any length of time, without any further exertion of the animal. They attain their full growth about the latter end of May, and are coming from the horse from this time to the latter end of June. On dropping to the ground, they soon change to the chrysalis, and in six or seven weeks the fly appears. This bott is larger and whiter than that of the œstrus hæmorhoidalis, which has a reddish cast; but in its structure, and situation in the animal, resembles the former. It is found, however, to hang about the rectum, previously to quitting it, which the large horse-bott never does.

Veterinary practitioners do not seem to have decided hitherto, whether these animals are prejudicial to the horse; nor even whether they may not be actually beneficial. Their almost universal existence at a certain season, even in animals perfectly healthy, shows that they produce no marked ill effect: yet the holes which they leave, where they were attached to the stomach, could hardly be made without causing some injurious irritation.

For the mode in which these botts gain admission into the stomach, as also for a most interesting general account of their history and structure, see Œstrus, which was furnished by Mr. Clark, and from which the preceding account is borrowed.

The food of carnivorous animals approaching in its constituent elements more nearly to those of the animal than that of the herbivorous tribes, is more easily reduced into the state which is required for the nourishment of the body, in the former than in the latter case. Hence arises a leading distinction between the stomachs of these classes. In the latter animals, the œsophagus opens considerably to the right of the great extremity, so as to leave a large cul de sac on the left side of the stomach; and the small intestine commences near the cardia, leaving a similar blind bag on the right. The food must be detained for a long time in such a stomach, as the passage from the œsophagus to the pylorus is indirect and highly unfavourable to speedy transmission. Animals of the mouse kind, and the rodentia, show this structure very well; it is very remarkable in the mus quercinus, (Cuvier, "Leçons," &c. tom. 5. pl. 36. fig. 11). In the carnivora, the stomach, which is of a cylindrical form, has no cul de sacs; the œsophagus opens at its anterior extremity, and the intestine commences from the posterior; so that every thing favours a quick passage of the food. Animals of the weasel kind, which are very truly carnivorous, exhibit this structure the most completely. The seal also exemplifies it, and the lion. (Cuvier, pl. 36. fig. 7).

The most complicated and artificial arrangement, both with respect to structure and mechanism, is found in the well-known four stomachs of the ruminating animals with divided hoofs; of this we shall take, as examples, the cow and sheep.

The first stomach, or paunch, (rumen, penula, magnus venter, ingluvies), is by far the largest in the adult animal; not so however in the recently born calf or lamb. It is divided externally into two saccular appendices at its extremity, and it is slightly separated into four parts on the inside. Its internal coat is beset with innumerable flattened papillæ.

This is followed by the second stomach, honeycomb bag, bonnet, or king's hood, (reticulum, ollula), which may be regarded as a globular appendage of the paunch; but is distinguished from the latter part by the elegant arrangement of its internal coat, which forms polygonal and acute-angled cells, or superficial cavities.

The third stomach, which is the smallest, is called the manyplus, which is a corruption of manyplies (echinus, conclave, centipellio, omasum): it is distinguished from the two former, both by its form, which has been compared to that of a hedgehog when

rolled up, and by its internal structure. Its cavity is much contracted by numerous and broad duplicatures of the internal coat, which lie lengthwise, vary in breadth in a regular alternate order, and amount to about 40 in the sheep, 100 in the cow.

The fourth, or the red, (abomasum, faliscus, ventriculus intestinalis), is next in size to the paunch, of an elongated, pyriform shape, with an internal villous coat like that of the human stomach, with large longitudinal rugæ.

The three first stomachs are connected with each other, and with a groove-like continuation of the œsophagus, in a very remarkable way. The latter tube enters just where the paunch, the second and third stomachs approach each other; it is then continued with the groove, which ends in the third stomach. This groove is therefore open to the first stomachs, which lie to its right and left. But the thick prominent lips which form the margin of the groove, admit of being drawn together so as to form a complete canal: which then constitutes a direct continuation of the œsophagus into the third stomach.

The functions of this very singular part will vary, according as we consider it in the state of a groove, or of a closed canal. In the first case, the grass, &c. is passed after a very slight degree of mastication, into the paunch, as into a reservoir. Thence it goes in small portions into the second stomach, from which, after a further maceration, it is propelled, by a kind of antiperistaltic motion, into the œsophagus, and thus returns into the mouth. It is here ruminated, and again swallowed, when the groove is shut, and the morsel of food, after this second mastication, is thereby conducted directly into the third stomach. During the short time which it probably stays in this situation between the folds of the internal coat, it is still further prepared for digestion, which process is completed in the fourth or true digestive stomach.

The phenomena of rumination suppose a power of voluntary motion in the part. And indeed the influence of the will in the whole function is incontestible. It is not confined to any particular time, since the animal can delay it according to circumstances, when the paunch is quite full. It has been expressly stated of some men, who have had the power of ruminating, (instances of which are not very rare), that it was quite voluntary with them. Blumenbach knew two men, who ruminated their vegetable food: both assured him that they had a real enjoyment in doing this, which has also been observed of others; and one of them had the power of doing it, or leaving it alone, according to circumstances.

The final purpose of rumination, as applicable to all the animals in which it takes place, and the chief utility of this wonderfully complicated function in the animal economy, are still completely unknown. What has been already suggested on these points is completely unsatisfactory. The old dream of Aristotle and Galen, that rumination supplies the place of incisor teeth, the materials of which are applied, in these animals, to the formation of horns, scarcely deserves mention. Perrault and others supposed that it contributed to the security of these animals, which generally eat much and are timid, by showing the necessity of their remaining long employed in chewing, in an open pasture. But the Indian buffalo ruminates, although it does not fly even from a lion, but rather attacks, and often vanquishes that animal: and the wild goat dwells in Alpine countries, which are inaccessible to beasts of prey.

The peculiar structure of the stomach in the camel and lama, which enables these animals to take at one time a sufficient quantity of water to last them for two, three, or more days, and thereby renders them adapted to inhabit the dry and sandy deserts, which constitute their natural abode, is highly worthy of attention. The fluid which they drink is deposited in numerous cells, formed in the substance of their first and second stomachs, by strong bands of muscular fibres crossing each other at right angles. It should seem that the animal has the power of closing these cells by the contraction of those fibres which form the mouths of the cavities, or of expelling the contained fluid by putting the other portions of fibres in action.

This cellular structure is found in two parts of the first stomach; and it occupies the whole of the second. It was found in a dead camel, that these cavities would hold two gallons of fluid; but they were probably more capacious during life, as the animal in question always drank six or seven gallons of water every other day, and took more in the intermediate time. Mr. Bruce states, in his travels, that he procured four gallons from one which he slaughtered in Upper Egypt. "Shaw's Abridgment of Bruce's Travels." Ed. 3. p. 371.

As all the food which the animal takes

passes into the first stomach, the water of the cells in that part becomes turbid; but it remains perfectly pure in the second, where it resides in the greatest quantity; which circumstance accounts for travellers being able to drink it on an emergency. The muscular bands, which form the groove described in the account of the ruminating stomach, are particularly strong; and by drawing the third stomach to the œsophagus, convey the ruminated food through the second without polluting the water in its cells. Hence the food that has been macerated in the paunch must be sent back to the mouth directly from that cavity, without passing into the second stomach, as it does in the cow. See "Observations on the camel's stomach respecting the water which it contains," &c. by E. Home, esq. Philos. Trans. 1806.

The structure of these parts in the lama, according to the account which Cuvier has given of them, from the examination of a fetus, does not seem to differ essentially from that of the camel.

There is a peculiar glandular body at the upper orifice of the beaver's stomach, about the size of a florin, full of cavities that secrete mucus. It resembles, on the whole, the bulbus glandulosus of birds, and assists in the digestion and animalization of the dry food which this curious animal takes, consisting chiefly of the bark and chips of trees, &c.

According to Cuvier, there is a gland as large as the head of a man situated between the coats of the stomach in the manati (trichechus manatus borealis). It is placed near the œsophagus, and discharges, on pressure, a fluid like that of the pancreas by numerous small openings.

Mr. Home is of opinion that a glandular structure exists in the stomach of the sea-otter near the pylorus. Philos. Trans. 1796, pl. 2. And Mr. Macartney has discovered an arrangement of glandular bodies in the dormouse, round the œsophagus just before its termination, similar in situation and appearance to the gastric glands of birds.

The stomach of the pangolin (manis pentadactyla) is almost as thick and muscular as that of the gallinaceous fowls, and contains, like that of granivorous birds, small stones and gravel, which are probably swallowed for the same purpose as in those birds.

ŒSOPHAGUS AND STOMACH OF BIRDS.

The œsophagus is of immense size in many carnivorous birds; considerably larger indeed than the intestinal canal. The capaciousness of this tube enables it to hold for a time the entire fish and large bones which these birds swallow, and which cannot be contained in the stomach; and to facilitate the discharge by vomiting the indigestible remains of the food which form balls of hair, feathers, and bony matter.

The œsophagus expands just before the sternum into the crop (ingluvies, prolobus, le jabot), which is furnished with numerous mucous or salivary glands, disposed in many cases in regular rows. In such birds as nourish their young from the crop, the glands swell remarkably at that time, and secrete a greater quantity of fluid. This part is found in land-birds only, but not in all of these; it exists in all the gallinæ, and in some birds of prey.

There is another glandular and secretory organ, much more common than the crop, belonging, indeed, most probably to the whole class. This is the bulbus glandulosus (echinus, infundibulum, proventriculus, corpus tubulosum), which is situated before the entrance of the œsophagus into the proper stomach, and whose form and structure vary considerably in the different genera and species. In the ostrich, for example, its magnitude and form give it the appearance of a second stomach. In some other birds, as the psittaci, ardeæ (crane, stork, &c.) its appearance is different from that of the proper stomach, but its size is larger; while, on the contrary, in gallinaceous fowls it is much smaller.

This bulbus glandulosus consists of a vast congeries of glands. The œsophagus, of which it is a dilatation, has a vast number of glandular bodies interposed between its tunics, and entirely surrounding the tube, so as to constitute the "Zone of gastric glands" of Mr. Macartney. These bodies have a hollow internally, and they open into the cavity of the bulbus by numerous very plain apertures. The fluid secreted by them passes into the gizzard and mixes with the food.

A deviation from the natural structure, which is completely unparalleled, occurs in the stomach of the cuckoo. The gizzard of this bird is covered, internally, with an abundance of short, bristly, and spiral hairs, lying close together.

The structure of the stomach differs most widely in the different orders and genera of this class. It appears merely as a thin membranous bag, in several of those which feed on flesh and insects, when compared with

the thick muscular globes of the granivorous genera. But there are in both many intermediate links between these extremes, and at the same time considerable analogies in the structures, which are apparently the most opposite. This is particularly observable in the course of the muscular fibres, and in the callous structure and appearance of the internal coat; in which points, many of what are called membranous stomachs, have a great resemblance to those of the gallinæ.

Both parts, but particularly the muscular, are very strong in the gizzard (ventriculus bulbosus) of granivorous birds. We find here, instead of a muscular coat, four immensely thick and powerful muscles, *viz.* a large hemispherical pair at the sides (laterales), and two smaller ones (intermedii) at the two ends of the cavity. All the four are distinguished, both by the unparalleled firmness of their texture, and by their peculiar colour, from all the other muscles of the body.

The internal callous coat must be considered as a true epidermis; since, like that part, it becomes gradually thicker from pressure and rubbing. It forms folds and depressions towards the cavity of the stomach; and these irregularities are adapted to each other on the opposed surfaces. The cavity of this curious stomach is comparatively small; its lower orifice is placed very near the upper. Every part of the organ is, indeed, calculated for producing very powerful trituration; and this is still further promoted by the well-known instinctive practice of granivorous birds, of swallowing small hard stones with their food.

The end and use of swallowing these stones have been very differently explained. Cæsalpinus considered it rather as a medicine than as a common assistance to digestion; Boerhaave, as an absorbent for the acid of the stomach; Redi, as a substitute for teeth; according to Whytt, it is a mechanical irritation adapted to the callous and insensible nature of the coats of the stomach; Spallanzani rejected all supposition of design or object, and thought that the stones were swallowed from mere stupidity. There seems not much sagacity to be discovered in this opinion, when we consider that these stones are so essential to the due digestion of the corn, that birds grow lean without them, although they may be most copiously supplied with food. This paradoxical opinion has, however, been already refuted by J. Hunter, and G. Fordyce. Blumenbach thinks that the stones kill the grain and deprive it of its vitality, which otherwise resists the action of the digestive powers. Thus it has been found that if the oats and barley, given to horses, be previously heated, the animal only requires half the quantity, and thrives equally well.

Reptiles and birds have their nostrils terminated by two longitudinal slits on the palate; they have no velum palati, nor epiglottis.

The œsophagus of the serpent kind is of immense magnitude; for these reptiles swallow animals larger than themselves, which are retained for a considerable time in the tube, and descend into the stomach by degrees, where they are slowly subjected to the action of the gastric juice. The whole process sometimes occupies many days, or even weeks. There is hardly any distinction between œsophagus and stomach.

From the peculiar formation of the nose of fishes, and from their respiring by means of gills, their fauces have no connection with any nasal cavity, or glottis.

The œsophagus is of great width in fishes, and is distinguished with difficulty in many cases from the stomach. These animals swallow their food whole without subjecting it to any mastication; and if the stomach will not hold the whole, a part remains in the œsophagus, until that which has descended lower is digested. The alimentary canal is generally very short; sometimes extending straight from the mouth to the anus with very little dilatation, as in the lamprey (petromyzon marinus).

The crustacea, and some insects, are furnished with organs of mastication of similar structure. Their mouth is formed of two or more pairs of jaws placed laterally. These move from without inwards, and vice versâ; whereas those of red-blooded animals move from above downwards, and back again. The parts which are termed the lips of insects are two bodies, of which one is placed above or in front of the jaws, and the other below or behind them. The palpi or feelers are articulated to the jaws. All insects, which have jaws, possess the power of masticating hard animal and vegetable substances; for these parts are of a firm horny texture, and in many cases are very large when compared with the size of the animal.

The locusts (grylli), the dragon-fly (libellula), the beetles, and particularly the lucanus cervus, or stag-beetle, and the staphylinus maxillosus, are examples in which

the jaws are very large and manifest, and often possess denticulated edges. All the genera of the following orders have jaws; *viz.* the coleoptera, orthoptera, neuroptera, and hymenoptera. The insects of the remaining orders derive their nourishment chiefly from liquids; which they get either from animal or vegetable substances by means of a spiral and tubular tongue, or a soft proboscis, as in the lepidoptera; with a broad opening, admitting of extention and retraction (the hemiptera); or a horny pointed tube, containing sharp bristly bodies internally (the diptera and aptera).

The stomach of the bee is a transparent membranous bag, in which the nectar of the flowers is elaborated and converted into honey. The animal vomits it up from this reservoir, and deposits it in the hive.

The stomach of the crab and lobster is a very singular organ. It is formed on a bony apparatus, in short a species of skeleton, and does not therefore collapse when empty. To certain parts of this bony structure, round the pylorus, the teeth are affixed. Their substance is extremely hard, and their margin is serrated or denticulated; as they surround the tube, near the pylorus, nothing can pass that opening without being perfectly comminuted. These bones and teeth are moved by peculiar muscles.

In those mollusca, which possess jaws, these parts are fixed in the flesh of the animal, as there is no head to which they can be articulated. They are two in number in the cuttle-fish, are composed of a horny substance, and resemble exactly the bill of a parrot. They are placed in the centre of the lower part of the body, and are surrounded by the tentacula, which enable the animal to attach itself to any objects. By means of these parts, the shell-fish, which are taken for food, are completely triturated. The common snail and slug have a single jaw semilunar in its form, and denticulated. The tritonia has two jaws which act like the blades of a pair of scissars. The other mollusca possess no organs of this kind, but have, in some instances, a sort of proboscis; as the buccinum, murex, voluta, doris, scyllæa, &c.

In the worms, properly so called, there are sometimes hard parts forming a kind of jaws or teeth; thus, in the nereis, the mouth possesses several calcareous pieces. The aphrodite (sea-mouse) has a proboscis, furnished with four teeth, which it can extend and retract at pleasure. Within the mouth of the leech are three semicircular projecting bodies, with a sharp denticulated edge: by this apparatus the animal inflicts its wound of the well known peculiar form in the skin.

The teeth of the echinus (sea-hedgehog) are of a very singular arrangement; a round opening is left in the shell for the entrance of the food; a bony structure, on which five teeth are placed, fills up this aperture; and as these parts are moved by numerous muscles, they form a very complete organ of mastication.

The stomach of the vermes, is in general, a membranous bag, but in some cases its structure is more complicated. The helix stagnalis and the onchidia have gizzards. The aplysia has three strong muscular stomachs, provided with pyramidal bony processes. The latter structures, together with those of the lobster and crab, present a new analogy, as Cuvier has observed, between the membranes of the intestines and the integuments of the body. This is particularly strengthened by the annual shedding of the lobsters teeth, when its crustaceous covering falls off.

The bulla lignaria has a very powerful stomach, containing three hard calcareous shells, by which the animal is enabled to bruise and masticate the other testacea on which it feeds.

ON THE INTESTINAL CANAL.

The intestinal canal (which is the most common part in the whole animal kingdom after the stomach) is distinguished in the mammalia by two peculiarities, which depend on the mode of nutrition. It is comparatively shorter in carnivorous animals, and there is also in these less difference to external appearance between the small and the large intestine than in the herbivora. Yet these rules are not without their exceptions; for the seal has very long, and the sloth very short intestines; the badger, which is not a proper carnivorous animal, and several true herbivora, as, for instance, the rell-mouse (glis esculentus) have no distinction between the large and small intestine, &c.

In considering the proportionate lengths of the intestinal canal, and the relation which these bear to the kind of food on which the animal subsists, many circumstances must be taken into the account besides the mere measure of the intestine. Valvular projections of the internal membrane; dilatations of particular parts of the canal; and a large general diameter, com-

pensate for shortness of the intestine; and vice versâ. The structure of the stomach must also be considered, as, whether it is formed of more than one cavity; whether the œsophagus and intestine communicate with it in such a manner as to favour a speedy transmission of the food, or whether there are cul de sacs which retain the aliment for a long time in the cavity. The formation of the jaws and teeth, and the more or less perfect trituration and comminution which the food experiences in the mouth, must likewise be viewed in connection with the length and structure of the alimentary canal.

The whole length of the canal is greater in the mammalia than in the other classes. It diminishes successively, as we trace it in birds, reptiles, and fishes, being shorter than the body in some of the latter animals, which is never the case in the three first classes.

In omnivorous animals the length of the canal holds a middle rank between those which feed on flesh and such as take vegetable food; thus, in the rat, its proportion to the body is as 8 to 1; in the pig 13 to 1; in man 6 or 7 to 1. The dimunition in length, in the latter case, is compensated by other circumstances, *viz.* the numerous valvulæ conniventes, and the preparation which the food undergoes by the art of cookery.

In carnivorous animals, every circumstance concurs to accelerate the passage of the alimentary matter. It receives no mastication; it is retained for a very short time in the stomach; the intestine has no folds or valves; it is small in diameter; and the whole canal, when compared to the body, is extremely short, being 3 or 5 to 1. In general there is no cæcum.

The ruminating animals present the opposite structure. The food undergoes a double mastication, and passes through the various cavities of a complicated stomach. The intestines are very long; 27 times the length of the body in the ram. Hence the large intestines are not dilated or cellular, nor is there a cæcum. The solipeda have not such a length of canal, nor is their stomach complicated; but the large intestines are enormous and dilated into sacculi; and the cæcum is of a vast size, equal, indeed, to the stomach. The rodentia, which live on vegetables, have a very large cæcum, and a canal 12 or 16 times as long as the body. In the rat, which can take animal, as well as vegetable food, the canal is shorter than in the other rodentia.

There are some exceptions to the rule which we have just mentioned, respecting the length of the canal in carnivorous and herbivorous animals. The seal, which takes animal food, has very long intestines: the sea-otter resembles it in this respect, and differs therein most remarkably from the common otter, which resembles other carnivorous animals in the shortness of its intestinal tube. The length of canal in the former is twelve times that of the animal, and only three times and a quarter in the latter. (Home, in the Philos. Trans. 1799, part 2.) Whales have likewise a longer canal than other carnivorous mammalia; their stomach is complicated, and the intestine has longitudinal folds. It seems, therefore, that a considerable length of intestinal canal is found in all mammalia, which live much in the water, although they are carnivorous.

The plantigrade animals, which have carnivorous teeth, but feed equally well on vegetables, have a long canal; but it is very narrow and possesses no cæcum, nor distinction of large intestine.

A species of bat (vespertilio noctula) seems to have the shortest intestinal canal of any mammalia; it is only twice the length of the animal's body. On the contrary, the roussette (vesp. vampyrus Linn. v. caninus Blum.) which lives entirely on vegetables, has it seven times as long.

In a few instances, as the beaver and sloth, the rectum and uretha have a common termination, which may be compared to the cloaca of birds. This resemblance is the most striking in the ornithorhynchus.

A remarkable difference is observed in the length of the canal between the wild and domesticated breeds of the same species. In the wild boar the intestines are to the body as nine to one; in the tame animal these proportions are as thirteen to one; in the domestic cat, five to one; in the wild cat, three to one; in the bull, twenty-two to one; in the buffalo, twelve to one. They are, on the contrary, longer in the wild than in the tame rabbit; the proportions in the former being eleven, and in the latter nine to one.

The proportion of the intestinal canal to the length of the body in birds, is as two, three, four, or five, to one. It is not always longest and largest in the graminivorous species, as many piscivorous birds have it equally long.

It is hardly twice the length of the body in many reptiles; and not so much in the

frog, although it is nine times as long as the space between the mouth and the anus in the tadpole.

The alimentary canal of some fishes is continued straight from the mouth to the anus, and does not, therefore, equal the length of the body. The lamprey, skate, and shark are thus circumstanced.

Most birds have two cæca, which are longer in the gallinæ than in the carnivorous tribes. The rectum ends in a part called the cloaca, which is a large membranous bag, containing also the termination of the ureters, that of the oviduct, the vasa deferentia, and of a membranous bag of unknown use, called bursa fabricii. This also holds the penis where there is one.

ALIMENTARY CANAL OF THE LOWER ORDERS.

The simple globular hydatid, which is frequently found in the different viscera both of man and quadrupeds, has been supposed by some to be an animal consisting entirely of a stomach. Doubts, however, have lately been raised whether or no this be really an animal. Even if it were allowed that these bags are animals, it does not follow that their cavity is a stomach; and the attachment of the young to the sides would rather justify us in considering it as the organ of generation.

The hydatid, which is more frequently found in animals, which possesses a head and mouth like the tænia, enabling it to attach itself to parts, and which can be seen to move when placed in warm water, is generally allowed to possess an independent vitality. But whether the bag of water, which forms its body, be a stomach, is certainly doubtful.

The most simple form of an alimentary cavity exists in the common fresh water polype (hydra). It appears to be excavated in the substance of the body, and has a single opening situated in the centre of the space surrounded by the tentacula. The nutritive matter soaks immediately into the body, and imparts its colour to the animal.

The large masses of gelatine, called medusæ, which resemble in form mushrooms, and are found floating in the sea, have a somewhat similar structure. A stomach is hollowed out in the pedicle; and vessels, commencing from its cavity, convey the nutritious fluid over the body. Sometimes the stomach has a simple opening; in other cases there are branching tentacula on which canals commence by open orifices; these unite together to form larger tubes, and the successive union of these vessels forms at last four trunks, which open into the stomach and convey the food into that cavity. This very singular structure constitutes a remarkable analogy to the roots of trees; and Cuvier has formed a new genus under an appellation derived from this comparison, *viz.* the rhizostoma, from ῥιζη a root, and ϛομα a mouth.

The star-fish (asterias) has a membranous cavity in the centre of its body, communicating externally by a single opening; two canals extend from this into each of the branches, or as they are sometimes called the fingers of the animal, where they subdivide and form numerous blind processes.

The tape-worm (tænia) has a small canal running on each side of its body; the two tubes are joined together by transverse productions at each joint.

The ascaris lumbricoides (round-worm) has a simple canal running from one extremity of the body to the other.

The leech (hirudo sanguisuga, or medicinalis) has a short œsophagus and a very large stomach, divided by numerous membranous septa, which are perforated in the centre. It has been generally supposed that this animal has no anus; but Cuvier says that it possesses a very small one. (Léçons d'Anat. Comp. tom. 4. p. 141) Dumeril, on the contrary, denies its existence. (Zoologie Analytique, p. 298.)

The common earth-worm (lumbricus terrestris) has a long canal, divided by several partitions.

The aphrodite aculeata has an intestine running according to the length of the body, and sending off on each side several blind processes, which enlarge at their termination.

In the proper mollusca, besides the stomach, which has been already noticed, there is an intestine, seldom of considerable length, making some turns in its course; it passes in all the acephalous mollusca through the heart.

The intestinal canal of insects varies very much in the different genera and species. It may be stated on the whole that a long and complicated intestinal tube denotes that the insect feeds on vegetables; while the contrary characters indicate animal food.

Great difference is found, in some instances, between the larva and the perfect insect. The voracious larvæ of beetles

(scarabæi) and butterflies, have intestines ten times as large as the winged insects which are produced from them.

In the dragon-fly (libellula), which is very carnivorous, the intestine is not longer than the body. There is a small but muscular stomach.

The orthoptera (which class contains the locusts, &c. well known for their destructive powers) have a long and complicated alimentary apparatus. They have first a membranous stomach. This is succeeded by another cavity covered internally with scales or teeth, and possessing a very thick muscular coat; in short, a true gizzard. Round the end of this the cæcal processes are attached. There is, lastly, an intestinal canal differing in length and diameter.

The alimentary canal runs straight along the body in the crustacea, and is uniform in its dimensions, excepting the stomach.

ON THE LIVER, SPLEEN, AND OMENTUM.

The spleen and omentum seem to be less constantly found in the animal kingdom than the liver, and to be in a manner subservient to the latter viscus; which, on the contrary, exists in every class and order of animals that is provided with a heart and circulating system.

It deserves to be remarked here, as a peculiarity of the liver of some four-footed mammalia, which live in or about the sea, namely, the polar bear and some seals, that it seems to possess some poisonous or noxious qualities when employed for food. Heemskerk's companions experienced this, in the former instance, at Nova Zemlia; and Lord Anson's squadron, in the latter, on the coast of Patagonia.

The liver of mammalia is in general divided into more numerous lobes; and the divisions are carried deeper into its substance, than in the human subject. This is particularly the case in the carnivora, where the divisions of the lobes extend through the whole mass. But, the utility, which Monro has assigned to this structure; *viz.* that of its allowing the parts to yield and glide on each other in the rapid motions of the animal, carries very little plausibility with it. "Essay on Comparative Anatomy," p. 11.

In many animals of this class, as the horse, the ruminantia, the pachydermata, and whales, the liver is not more divided than in man.

The ductus choledochus forms a pouch between the coats of the intestine, for receiving the pancreatic duct, in the cat and elephant.

All the quadrumana, carnivora, and edentata have a gall-bladder.

Many rodentia, particularly among the rats, want it. The tardigrada; the elephant, rhinoceros, and pecari among the pachydermata; the genus cervus and camelus among the ruminating animals; the solipeda; the trichechus and porpoise also want this part. It does not exist in the ostrich and parrot; but is found in all the reptiles. Cuvier thinks that it belongs particularly to carnivorous animals; that it is connected with their habit of long fasting; and serves as a reservoir for the bile.

All the mammalia, which want it, except the porpoise, are vegetable eaters: and most reptiles, which universally possess it, live on animal food.

The liver of birds is divided into two equal lobes. The hepatic duct opens separately from the cystic; and its termination is generally, but not always, preceded by one or more pancreatic ducts, and followed by that of the cystic duct.

The fundus of the gall-bladder receives branches from the hepatic duct, ("ductus hepaticystici"); but that tube sometimes unites with the cystic, as in the duck.

Some fishes, which are almost destitute of fat in the rest of their body, have an abundance of oil in the liver, as for instance, the skate and cod.

The spleen gradually diminishes in size from the mammalia to fishes. In the porpoise there are several small spleens, supplied from the arteries of the first stomach. It is always attached to the first, when there are several stomachs.

In birds it is always near the bulbus glandulosus, but does not lie constantly very close to the stomach in reptiles, as it is found in the mesentery of the frog; neither is it very uniformly situated in fishes.

In the crustacea the liver is large, and consists of blind tubes, opening into the commencement of the intestine. It forms the soft high flavoured substance of the crab and lobster.

A liver exists in all the mollusca, and is very large; but this class has no gall-bladder. The liver is supplied with blood from the aorta, and there is consequently no vena portarum.

It is a completely mistaken notion, that the black fluid of the cuttle-fish is its bile. The ink-bag is indeed found between the two lobes of the liver in the sepia octopus;

and in front of them in the calmar; but in the common cuttle-fish ("sepia officinalis"), it is at a considerable distance from this organ.

The real bile is poured, as usual, into the alimentary canal.

The structure of the pancreas in the mammalia, in birds, and in reptiles is the same, on the whole, as in the human subject, its form and size, its colour and consistence, and its division into lobules exhibit some slight and unimportant variations.

The termination of its duct or ducts is distinct in birds from that of the D. choledochus. In the mammalia they generally open together, or there is a branch terminating in the D. choledochus, and another opening into the intestine, as in the dog and elephant, or they may be quite distinct, as in the hare, porcupine, and marmot. They may be separate or distinct in different individuals of the same species, as in the monkeys.

The skate and shark have a pancreas similar to that of the three first classes of red-blooded animals. In other fishes the situation of this organ is occupied by numerous small tubes, called the cæcal appendices, or pyloric cæca; which afford a copious secretion, analogous, no doubt, to the pancreatic liquor. The internal surface of these tubes becomes very red on injection, and possesses a glandular and secreting appearance. Their number varies from one to several hundreds.

The description of the organs, which are concerned in assimilating the food, and in converting it into chyle, will be naturally followed by that of the blood-vessels which carry it to all parts of the body, of the organs of respiration, which subject it to contain important changes, and of the absorbent system.

ORGANS OF CIRCULATION.

A perfect circulating system, to which on the one hand fluids are brought by the absorbents to be converted into blood; and from which on the other side, various juices are separated in glands, and viscera of a glandular structure, appears to belong universally and exclusively to red-blooded animals. A pericardium exists in all these animals. Parts of such a system, particularly a heart, and certain vessels connected with it, are found in some genera of the white blooded classes.

It has been supposed, that the amphibious animals of this class, and the cetacea have an open foramen ovale, like that of the fœtus, in their septum auricularum. And the necessity of such an opening has been inferred from their way of life; since they often pass a considerable time under water without breathing. This supposition has been fully refuted by the repeated dissection of adult animals of this kind; which has shewn that an exception from the general rule very rarely occurs.

In several genera and species of web-footed mammalia, and cetacea (that is, in the common and sea-otters, in the dolphin, &c.) particular vessels have been observed to be considerably and constantly enlarged and tortuous. This structure has been principally remarked in the inferior vena cava; where there can be no doubt that it serves, while the animal is under water, to receive a part of the returning blood, and to retain it until respiration can be again performed, and the lesser circulation be thereby again put in action.

There are some remarkable circumstances in the distribution of particular arteries in certain animals of this class. We may notice, as the most singular of these, the rete mirabile, formed by the internal carotid at its entrance into the cranium, in several ruminating biscula, and carnivorous animals: and that division of the arterial trunks of the extremities, which has been observed by Mr. Carlisle in the slow-moving animals, *viz.* the sloths, and lemur tardigradus. The arteries of the arm and thigh in these cases, divide as they leave the trunk into numerous parallel branches, which are united again towards the elbow and knee.

All birds possess a very remarkable peculiarity in the structure of the heart. The right ventricle, instead of having a membraneous valve (such as are found in both ventricles of mammalia, and also in the left of birds), is provided with a strong, tense, and nearly triangular muscle. This singular structure assists in driving the blood with greater force from the right side of the heart into the lungs; since the expansion of the latter organs by respiration, which facilitates the transmission of the carbonated blood in mammalia, does not take place in birds, on account of the connection which their lungs have with the numerous air-cells, which will be afterwards described.

Frogs, lizards, and serpents, have a simple heart, consisting of a single ventricle and auricle.

The structure of this part is very different in the turtle, and has given rise to more controversy than that of any order of animals. Their heart possesses two auricles, which are separated by a complete septum, like those of warm-blooded animals, and receive their blood in the same manner as in those animals, *viz.* the two venæ cavæ terminate in the right auricle, the pulmonary veins in the left. Each pours its blood into the corresponding ventricle, of which cavities there are two: thus the structure of the heart hitherto resembles that of mammalia.

The characteristic peculiarities which distinguish the heart of these animals, consist in two circumstances: first, both the ventricles communicate together; there is a muscular, and as it were tubular valve, going from the left to the right cavity, by means of which the former opens into the latter. Secondly, the large arterial trunks arise all together from the right ventricle only, (no vessel coming from the left.) The aorta forming three grand trunks, is situated towards the right side and the upper part; the pulmonary artery comes as it were from a particular dilatation, which is not situated in the middle of the basis of the heart, but lower; (it must be understood, that we apply these terms according to the horizontal position of the animal.)

We can now comprehend how this wonderful and anomalous structure, by which all the blood is propelled from the right ventricle only, is accommodated to the peculiar way of life of the animal, which subjects it frequently to remaining for a long time under water. For the greater circulation is so far independent of that which goes through the lungs, that it can proceed while the animal is under water, and thereby prevented from respiring, although the latter is impeded. In warm-blooded animals, on the contrary, no blood can enter the aorta, which has not previously passed through the lungs into the left ventricle; and hence an obstruction of respiration most immediately influences the greater circulation.

The heart in this class of animals is extremely small in proportion to the body. Its structure is very simple, as it consists of a single auricle and ventricle, which correspond with the right side of the heart in warm-blooded animals. The ventricle gives rise to a single arterial trunk, (which is expanded in most fishes into a kind of bulb as it leaves the heart,) going straight forwards to the branchiæ, or organs of respiration. The blood passes from these into a large artery, analogous to the aorta, which goes along the spine and supplies the body of the animal. It is then returned by the venæ cavæ into the auricle.

It appears that insects possess neither blood-vessels nor absorbents. Cuvier has examined, by means of the microscope, all those organs in this class, which in red-blooded animals are most vascular, without discovering the least appearance of a blood-vessel, although extremely minute ramifications of the tracheæ are obvious in every part. And Lyonet has traced and delineated in the caterpillar, parts infinitely smaller than the chief blood-vessels must be, if any such existed. "Anatomie de la Chenille," &c.

Yet insects, both in their perfect, and in their larva state, have a membranous tube running along the back, in which alternate dilatations and contractions may be discerned. From this circumstance it has been supposed to be the heart; but it is closed at both ends, and no vessels can be perceived to originate from it.

It is obvious from these data, that the functions of nutrition and secretion must be performed, in the animals which we are now considering, in a very different manner from that which obtains in the more perfect classes. Cuvier expresses the mode, in which he supposes growth and nutrition to be effected, by the term "imbibition." And he explains from this circumstance, the peculiar kind of respiration which insects enjoy. Since the nutritive fluids have not been exposed to the atmosphere, before they arrive at the parts for whose nourishment they are destined; this exposure is effected in the parts themselves by means of the air-vessels, which ramify most minutely over the whole body. "En un mot, le sang ne pouvant aller chercher l'air, c'est l'air, qui va chercher le sang."

The heart of the crustacea, according to Cuvier, has no auricle; and it is what he calls an aortic heart. For it expels the blood into the arteries of the body; and this fluid passes through the gills previously to its reaching the heart again. The different parts of the system are here found under a mode of connection exactly the reverse of what we observe in fishes; where the blood is sent into the gills, and passes subsequently into the aorta. The circulat-

ing organ in that class is therefore a pulmonary heart.

According to Cuvier, the cuttle-fish has three hearts, neither of which possesses an auricle. Two of these organs are placed at the root of the two branchiæ: they receive the blood from the body, (the vena cava dividing into two branches, one for each lateral heart) and propel it into the branchiæ. The returning veins open into the middle heart; from which the aorta proceeds.

The other mollusca have a simple heart, consisting of one auricle and ventricle. The vena cava assumes the office of an artery, and carries the returning blood to the gills; whence it passes to the auricle; and is subsequently expelled into the aorta. Here therefore, as in the crustacea, the heart is a pulmonary one.

The vermes of Cuvier have circulating vessels, in which contraction and dilatation are perceptible, without any heart. They can be seen very plainly in the lumbricus marinus. The leech, naias, nereis, aphrodite, &c. are further examples of the same structure. This anatomist is of opinion that the mollusca, crustacea, and vermes, possess no absorbing vessels; and he thinks that the veins absorb, as he finds them to have communication with the general cavity of the body, particularly in the cuttle-fish. Hence the above mentioned classes will hold an intermediate rank between the vertebral animals, which possess both blood-vessels and absorbents, and the insects which have neither.

ABSORBING SYSTEM.

The chyle of birds is transparent: and there are no mesenteric glands in these animals.

The lacteals are uncommonly numerous on the intestines, and mesentery of the turtle, in which animal there are no absorbent glands.

The lymphatics of fishes have neither glands nor valves.

ORGANS OF RESPIRATION.

The incessant continuation of the great chemical process, by which oxygen is exchanged for hydrogen and carbon, is essentially necessary to the well being of the greater part of animals. Yet the organs and mechanism, by which this wonderful function is carried on, vary very considerably. In the mammalia after birth; in birds when they have left the egg; and in amphibia when completely formed, the chief organ of this function is the lungs: in fish it is performed in the gills; in most insects in their tracheæ; in the vermes, in analogous, but at the same time very different parts.

The respiratory organs of birds constitute one of the most singular structures in the animal economy, on account of several peculiarities which they possess; but more particularly in consequence of their connection with the numerous air-cells, which are expanded over the whole body.

The lungs themselves are comparatively small, flattened, and adhering above to the chest, where they seem to be placed in the intervals of the ribs; they are only covered by the pleura on their under surface, so that they are in fact on the outside of the cavity of the chest, if we consider that cavity as being defined by the pleura: a great part of the thorax, as well as the abdomen is occupied by the membranous air-cells, into which the lungs open by considerable apertures. Those of the thorax are divided, at least in the larger birds, by membranous transverse septa, into smaller portions; each of which, as well as the abdominal cells, has a particular opening of communication with the air-cells of the lungs, and consequently with the trachea. The membranes of these cells, in the larger birds, are provided here and there with considerable fasciculi of muscular fibres, which have been regarded as a substitute for the diaphragm, which is wanting in this class of animals. They also serve very principally, as we may ascertain by examining large birds in a living state, to drive back again into the lungs, the air which they received in inspiration; whence the repletion and depletion of the thoracic cells must alternate with those of the abdominal cavities.

Besides these cells, a considerable portion of the skeleton is formed into receptacles for air in most birds, (for there are indeed exceptions and considerable variations in the different genera and species.) This structure is particularly marked in the larger cylindrical bones, as the scapula, clavicle and femur. It is also found in most of the broad and multangular bones of the trunk, as the sternum, ossa innominata, dorsal vertebræ, &c. All these are destitute of marrow in the adult bird, at least in their middle; so that the cylindrical bones form large tubes, which are only interrupted towards the extremities by a

sort of transverse bony fibres: the broad bones are filled with a reticulated bony texture, the cells of which are empty. They have considerable apertures, (most easily shewn in those extremities of the cylindrical bones which are turned towards the sternum) communicating with the lungs by small air-cells; which facts may be shewn by various experiments on living and dead birds.

These receptacles of air probably serve the purpose of lightening the body of the bird in order to facilitate its motions. This effect is produced in most birds to assist their flight; in some aquatic species, for the purpose of swimming; in the ostrich and some others, for running. Hence we find the largest and most numerous bony cells in birds which have the highest and most rapid flight, as the eagle, &c. And hence also the bones of the bird which has just left the egg, are filled with a bloody marrow, which is absorbed soon after birth, entirely in some, in others, particularly among the aquatic species, at least for the greater part.

Besides the uses which have been already pointed out, these receptacles of air diminish the necessity of breathing frequently in the rapid and long continued motions of several birds, and in the great vocal exertions of the singing birds.

The lungs of amphibia are distinguished from those of warm-blooded animals, both by a great superiority in point of size, as well as by a greater looseness of texture: arising from the great size of their air-vesicles. In frogs, lizards, and serpents, the lungs consists of a cavity, whose sides are cellular. The posterior part of the organ either forms a mere membranous bag, or else the cells are larger there than elsewhere. In the turtle the vesicles are very large, but the texture is uniform throughout.

In the tadpole, and the young of such lizards as bring forth in water, there are two organs, which somewhat resemble the gills of a fish (appendices fimbriatæ Swammerdam.) These serve for the purposes of respiration while the animal lives in the water. They are connected to the sides of the neck, and hang loose from the animal; they are not permanent, but are gradually withdrawn into the chest, (within a few days, in the reptiles of this country,) where their remains may still be perceived for some time near to the true lungs. Instead of the branchial opening, by which fishes again discharge the water which they have taken in at the mouth, some tadpoles have for this purpose a canal on the left side of the head near the eye; which must be distinguished from the small tube on the lower lip, by which they attach themselves to aquatic plants.

Instead of lungs, fishes are furnished with gills or branchiæ; which are placed behind the head, on both sides, and have a moveable gill cover (operculum branchiale,) which is wanting in the order of pisces chondropterygii only. By means of these organs, which are connected with the throat, the animal receives its oxygen from the air contained in the water; as those animals which breathe, derive it immediately from the atmosphere. They afterwards discharge the water through the branchial openings (aperturæ branchiales); and therefore they are distinguished from animals of the three preceding classes by this circumstance; *viz.* that they do not respire by the same way that they inspire.

We have already shewn in speaking of the organs of circulation, how the gills receive the venous blood by means of the branchial artery, and how this blood is sent into the aorta after its conversion into the arterial state. The distribution of these vessels on the folds and divisions of the gills constitutes one of the most delicate and minute pieces of structure in the animal economy.

Each of the gills consists in most fishes of four divisions, resting on the same number of arched portions of bone or cartilage, connected to the os hyoides. Generally there is only a single opening for the discharge of the water; but in many cases, particularly among the cartilaginous fishes, there are several.

Many animals of this order possess a single or double swimming bladder; which has been found in different instances to contain azote, hydrogen, and oxygen. It has not been hitherto determined, whether it be subservient to any other functions, besides that well known one from which its name is derived. In the mean time, like the air-receptacles of birds, it may be considered without impropriety in the present division of the work.

It is placed in the abdomen, and closely attached to the spine. It communicates generally with the œsophagus, and sometimes with the stomach, by a canal (ductus pneumaticus,) containing in some instances, as the carp, valves which seem to allow the

passage of air from the bladder, but not to admit its entrance from without.

That white-blooded animals indispensably require a species of respiration, would have been inferred by analogy from the wonderful apparatus of gills or tracheæ, which have been discovered in most orders of both classes of these beings. But in many cases direct proof has been obtained on this point: experiment has actually proved the exchange of carbon for oxygen.

White-blooded animals are moreover distinguished from those which have red blood, by this circumstance; that none of the former, as far as we hitherto know, take in air through the mouth.

Many aquatic insects as the genus cancer have a species of gills near the attachment of their legs. The others, and particularly the land-insects, which constitute, as is well known, by far the greatest number of this class of animals, are furnished with air-vessels, or tracheæ, which ramify over most of their body. These tracheæ are much larger and more numerous in the larva state of such insects as undergo a metamorphosis, (in which state also the process of nutrition is carried on to the greatest extent) than after the last, or, as it is called, the perfect change has taken place.

A large air-tube (trachea) lies under the skin on each side of the body of larvæ, and opens externally by nine apertures (stigmata): it produces on the inside the same number of trunks of air-vessels (branchiæ,) which are distributed over the body in innumerable ramifications.

Both the tracheæ and branchiæ are of a shining silvery colour; and their principal membrane consists of spiral fibres. The most numerous and minute ramifications are distributed on the alimentary canal.

There is great variety in the number and situation of the external openings, by which insects receive their air.

In most instances the stigmata are placed on both sides of the body. The atmospheric air enters by an opening at the end of the abdomen in several aquatic larvæ, and even perfect insects. A very remarkable change in this respect takes place in several animals of this class during their metamorphosis. Thus in the larva of the common gnats (culex pipiens,) the air enters by an opening on the abdomen: while in the nympha of the same animal, it gains admission by two apertures on the head.

In the class of vermes, which comprehends such very different animals, the structure of the respiratory organs is proportionally various. Some orders, as those which inhabit corals, the proper zoophytes, and perhaps the intestinal worms, appear to be entirely destitute of these organs; so that if any vital function, analogous to respiration, is carried on in these animals, it must be effected by methods which yet remain to be discovered.

Those vermes, however, which are furnished with proper organs of respiration, have the same variety in their structure, which was remarked in insects. Some, as the cuttle-fish, oyster, &c. have a species of gills, varying in structure in different instances. But the greatest number have air-vessels or tracheæ. Several of the testaceous vermes have both kinds of respiratory organs. In some of the inhabitants of bivalve shells, as the genus venus, the air-vessels lie between the membranes of a simple or double tubular canal, found at the anterior part of the animal, and capable of voluntary extension and retraction. It serves also for other purposes, as laying the eggs. The margins of its mouth are beset with the openings of the tracheæ.

In the terrestrial gasteropodous mollusca, of which we may instance the snail and slug, there is a cavity in the neck receiving air by a small aperture, which can be opened or shut at the will of the animal. The pulmonary vessels ramify on the sides of the cavity.

ORGAN OF THE VOICE.

Aristotle has correctly observed, that those animals only which possess lungs, consequently the three first classes of the animal kingdom possess a true voice. Several genera and species even of these are either entirely dumb, as the anteater, the manis, the cetacea, the genus testudo, several lizards and serpents; or they lose their voice in certain parts of the earth, as the dog in some countries of America, and quails and frogs in several parts of Siberia.

Most mammalia have the following circumstances in common: their rima glottidis is provided with an epiglottis, which in most instances has a peculiar muscle, arising from the os hyoides, and not found in the human subject: the margins of this rima are formed by the double ligamenta glottidis (ligamenta thyreoarytænoidea); between which the ventriculi laryngis are formed. The epiglottis does not exist in most of the bat kind: and in some mouse-like animals,

as the rell-mouse (glis esculentus), it is hardly discernible. The superior ligamenta glottidis, as well as the ventriculi laryngis, are wanting in some bisulca, as the ox and sheep.

Some species of mammalia have a peculiar and characteristic voice; or at least certain tones, which are formed by additional organs. Of this kind are certain tense membranes in some animals; and in others peculiar cavities, opening into the larynx, and sometimes appearing as continuations of the ventriculi laryngis.

The neighing of the horse, for example, is effected by a delicate and nearly falciform membrane, which is attached by its middle to the thyroid cartilage, and has its extremities running along the external margins of the rima glottidis.

The peculiar sound uttered by the ass is produced by means of a similar membrane, under which there is an excavation in the thyroid cartilage. There are moreover two large membranous sacs opening into the larynx.

The mule does not neigh like the mare by which it was conceived, but brays like the ass which begot it. It possesses exactly the same larynx as the latter, without any of the peculiar vocal organs of the mother; a fact which, like many others, cannot be at all reconciled with the supposed pre-existence of previously formed germs in the ovarium of the mother.

Several apes and baboons, as also the rein-deer, have on the front of the neck large single or double laryngeal sacs, of various forms and divisions, communicating with the larynx by one or two openings between the os hyoides and thyroid cartilage.

Some of the cercopitheci, as the C. Seniculus, and beelzebub, have the middle and anterior part of the os hyoides formed into a spherical bony cavity, by which the animals are enabled to produce those terrific and penetrating tones which can be heard at vast distances, and have gained them the name of the howling apes.

The most striking peculiarity in the vocal organs of birds, and which belongs to all birds with a very few exceptions, consists in their possessing what is commonly called a double larynx, but which might be more properly described as a larynx, divided into two parts, placed at the upper and lower ends of the trachea. They have also two rimæ glottidis.

The superior, or proper rima glottidis, is placed at the upper end of the trachea; but is not furnished with an epiglottis. The apparent want of this organ is compensated in several cases by the conical papillæ placed at both sides of the rima.

The apparatus which is chiefly concerned in forming the voice of birds is found in the inferior, or bronchial larynx. This contains a second rima glottidis, formed by tense membranes, which may be compared in several cases, particularly among the aquatic birds, to the reed at the mouth of musical instruments. It is furnished externally with certain pairs of muscles, varying in number in the different orders and genera; and with a kind of thyroid gland. The course and proportionate length of the trachea, and particularly the structure of the inferior larynx, vary very considerably in the different species, and even in the two sexes, especially among the aquatic birds. Thus, for example, the tame or dumb swan (anas olor) has a straight trachea; whilst in the male of the wild, or whistling swan (cygnus), this tube makes a large convolution, which is contained in the hollow of the sternum. In the spoonbill (Platalea leucorodia), as also in the Phasianus motmot, and others, similar windings of the trachea are found, not enclosed in the sternum. The males of the two genera anas and mergus have at their inferior or bronchial larynx a bony cavity, which contributes to strengthen their voice.

A very little comparison of the mechanism of wind musical instruments with the organs of the voice in birds will shew how nearly they are allied to each other; and it may be observed, that the sound produced by some of the larger birds is exactly similar to the notes that proceed from a clarionet or hautboy in the hands of an untutored musician. The inferior glottis exactly corresponds to the reed, and produces the tone or simple sound. The superior larynx gives it utterance, as the holes of the instrument; but the strength and body of the note depend upon the extent and capacity of the trachea, and the hardness and elasticity of its parts. The convolution and bony cells of the windpipe, therefore, may be compared with the turns of a French horn, and the divisions of a bassoon; and they produce the proper effects of these parts in the voices of those birds in which they are found.

BRAIN AND NERVES, AND ORGANS OF SENSE.

The parts subservient to the animal functions, which constituting the leading cha-

racter of animals, have derived their name from that circumstance, afford to our observation a more clear and manifest gradation, from the most simple to the most compound structure, than any others in the animal economy.

In some of the most simple animals of the class vermes, particularly among what are called zoophytes, little or no distinction of similar parts (or structures) can be discerned, and we are unable to recognize any thing as a particular nervous system, or even as a part of such a system. The power of sensation and voluntary motion which these possess, as well as any other order or class of the animal kingdom, proves that the nervous matter must be uniformly spread throughout their homogeneous substance. The almost transparent polypes (hydra), which are often found with a body of an inch in length, and arms or tentacula of a proportionate size, appear to consist, when surveyed in the best light by the strongest magnifying powers, of nothing but a granular structure connected into a definite form by a gelatinous substance.

In many other vermes, and in insects, particular nerves can be distinguished, arising in general from a chord running the whole length of the body, and called the spinal marrow, the superior extremity of which part, slightly enlarged, constitutes the brain. The latter organ, however, in both classes of cold and red-blooded animals, and still more in those which have warm blood, has a much more complicated structure, and a far greater relative magnitude: all animals are however exceeded in both these points by the human subject, which, according to the ingenious observation of the learned Sömmerring, possesses by far the largest brain in proportion to the size of the nerves which arise from it.

The vast superiority of man over all other animals in the faculties of the mind, which may be truly considered as a generic distinction of the human subject, led physiologists at a very early period to seek for some corresponding difference in the brains of man and animals. They naturally investigated the subject in the first instance, by comparing the proportion which the mass of the brain bears to the whole body; and the result of this comparison in the more common and domestic animals was so satisfactory, that they prosecuted the inquiry no further, but laid down the general proposition, which has been universally received since the time of Aristotle, that man has the largest brain in proportion to his body. Some more modern physiologists, however, in following up this comparative view in a greater number of animals, discovered several exceptions to the general position. They found that the proportion of the brain to the body in some birds exceeds that of man; and that several mammalia (some quadrumana, and some animals of the mouse kind) equal the human subject in this respect.

As these latter observations entirely overturned the conclusion which had been before generally admitted, Sömmerring has furnished us with another point of comparison, that has hitherto held good in every instance: *viz.* that of the ratio, which the mass of the brain bears to the nerves arising from it.

Let us divide the brain into two parts; that which is immediately connected with the sensorial extremities of the nerves, which receives their impressions, and is therefore devoted to the purposes of animal existence. The second division will include the rest of the brain, which may be considered as connecting the functions of the nerves with the faculties of the mind. In proportion then as any animal possesses a larger share of the latter and more noble part; that is, in proportion as the organ of reflection exceeds that of the external senses, may we expect to find the powers of the mind more vigorous and more clearly developed. In this point of view man is decidedly pre-eminent: here he excels all other animals that have hitherto been investigated.

All the simiæ, says Sömmering, are placed far behind man in this respect. Although the brain in some instances, particularly among the smaller kinds, which have prehensile tails, is larger in proportion to their body than that of the human subject; yet a very large share of that brain is required for the immense nerves which supply their organs of sense and mastication. Let us remove that portion of the brain, and a very small quantity will remain.

The researches of the same author on animals in general have led him to conclude, that the quantity of brain, over and above that which is necessary for a mere animal existence; that part, in short, which is devoted to the faculties of the mind, bears a direct ratio to the docility of the animal, to the rank which it would hold in a comparative scale of mental powers.

The largest brain, which Sömmerring has found in a horse, weighed 1*lb.* 4*oz.* and the

smallest, which he has seen in an adult man, was *2lb. 5½oz.* Yet the nerves arising from the former brain were at least ten times larger than those of the latter.

Generally speaking small animals have a larger brain in proportion to their body than larger ones. The pachydermata have it very small; and in red-blooded animals, its size is very trifling when compared with the body.

It forms in man from $\frac{1}{22}$ to $\frac{1}{33}$ of the body.

In some simiæ	$\frac{1}{22}$
the Mole	$\frac{1}{36}$
Bear	$\frac{1}{265}$
Dog	$\frac{1}{161}$
Cat	$\frac{1}{94}$
Hare	$\frac{1}{228}$
Rat	$\frac{1}{76}$
Mouse	$\frac{1}{43}$
Elephant	$\frac{1}{500}$
Pig	$\frac{1}{451}$ — $\frac{1}{672}$
Horse	$\frac{1}{400}$
Dolphin	$\frac{1}{50}$ — $\frac{1}{102}$
Eagle	$\frac{1}{200}$
Sparrow	$\frac{1}{25}$
Chaffinch	$\frac{1}{27}$
Redbreast	$\frac{1}{32}$
Blackbird	$\frac{1}{68}$
Canary-bird	$\frac{1}{14}$
Cock	$\frac{1}{25}$
Duck	$\frac{1}{257}$
Goose	$\frac{1}{360}$
Tortoise	$\frac{1}{2240}$
Turtle	$\frac{1}{5688}$
Coluber natrix	$\frac{1}{792}$
Frog	$\frac{1}{172}$
Shark	$\frac{1}{2496}$
Pike	$\frac{1}{1305}$
Carp	$\frac{1}{560}$

Many mammalia possess a bony tentorium cerebelli. It is difficult to give a physiological explanation of the use of this bony tentorium. The opinion which has been generally adopted by anatomists, that the structure in question belongs to such animals only as jump far, or run with great velocity, and that it serves the purpose of protecting the cerebellum from the pressure of the cerebrum in these quick motions is obviously unsatisfactory. It exists in the bear, which is not distinguished for its activity; while several animals which excel in jumping or springing do not possess it; *viz.* the wild goat, (capra ibex). Cheselden ascribes it to predacious animals only ("Anat. of the Bones," cap. 8); but it exists in several others.

We have given these remarks on the generally assigned use of the bony tentorium, because a similar mechanical explanation has been assigned of the falx and the tentorium of the human subject; *viz.* that the former protects the hemispheres from mutual pressure when the person lies with his head resting on one side; and that the latter provides against the compression of the cerebellum by the superincumbent cerebrum. These explanations are assigned in the present day by anatomists of such distinguished reputation as Sömmerring and Cuvier ("de Corporis Humani Fabricâ," vol. 4, p. 27. "Leçons d'Anat. compar." tom. 2, p. 178). If the futility of this piece of physiology were not sufficiently proved by considering that the cranium is accurately filled, and that there is consequently no room for its contents to fall from one side to the other; it must immediately be rendered manifest by Mr. Carlisle's case; in which the falx was entirely absent, and the two hemispheres united throughout in one mass, without any perceptible inconvenience during the patient's life. ("Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge," vol. ii. p. 212). We have met with four instances in which the anterior half of the falx was deficient. This production of the dura mater commenced in a narrow form about the middle of the sagittal suture; and gradually expanding, had acquired the usual breadth at its termination in the tentorium. The two hemispheres adhered by the pia mater covering their opposed plane surfaces, but were formed naturally in other respects. A want of the falx has also been recorded by Garengeot ("Splanchnologie," tom. ii. p. 24.)

The brain of the mammalia wants the digital cavity of the lateral ventricle, and in general the acervulus of the pineal gland. Its anterior lobes are elongated into a process called the mamillary, giving rise to the olfactory nerves. In birds, reptiles, and fishes, there is a successive and gradual change towards a more simple structure; the brain in these classes consisting merely of tubercular eminences. In the lower orders the brain seems to be really wanting. A nervous chord runs along the body, and possesses ganglia at different distances, from which the nerves arise. In insects and vermes the upper ganglion of the nervous chord, which represents the brain, is placed near the mouth, or œsophagus, and very generally surrounds that tube by a kind of collar.

ORGANS OF SENSE.

Few subjects in comparative anatomy and physiology have given rise to more various and contradictory opinions than the organs of sense in some classes of animals. Much misunderstanding on this point has clearly arisen from the inconsiderate and unconditional application of inferences drawn from the human subject to animals. Thus it has been supposed, that those which possess a tongue must have it for the purpose of tasting, and that the sense of smell must be wanting where we are unable to ascertain the existence of a nose. Observation and reflection will soon convince us, that the tongue, in many cases (in the ant-eaters among the mammalia, and almost universally in birds), cannot from its substance and mechanism be considered as an organ of taste; but must be merely subservient to the ingestion and deglutition of the food. Again, in several animals, particularly among insects, an acute sense of smell seems to exist, although no part can be pointed out in the head which analogy would justify us in describing as a nose.

However universally animals may possess that feeling which makes them sensible to the impressions of warmth and cold, very few possess, like the human subject, organs exclusively appropriated to the sense of touch, and expressly constructed for the purpose of feeling, examining, and exploring the qualities of external objects.

This sense appears, according to our present state of knowledge, to exist only in three classes of the animal kingdom; *viz.* in most of the mammalia, in a few birds, and probably in insects.

The structure of the organ of touch is the most perfect, and similar to that of the human subject in the quadrumana. The ends of their fingers, particularly of the posterior extremities, are covered with as soft and delicately organized a skin as that which belongs to the corresponding parts in man.

Several of the digitata are probably provided with this sense. The organization of the under surface of the front toes of the racoon (ursus lotor), and the use which the animal makes of those parts, prove this assertion.

It is not so clear that we are authorised in considering the snout of the mole and pig, not to mention the tongue of the solidungula and bisulca, or the snout of these and other animals, as true organs of touch according to the explanation above laid down.

Much less can we suppose the long bristly hairs, which constitute the whiskers of the cat-kind, and other mammalia, to be organs of touch in the sense we are now considering, although they may be serviceable, when they come in contact with any object, in warning, and making the animal attentive. Bats have been supposed to possess a peculiar power of perceiving external objects, without coming actually into contact with them. In their rapid and irregular flight amidst various surrounding bodies, they never fly against them; yet it does not seem that the senses of hearing, seeing, or smelling, serve them on these occasions; for they avoid any obstacles with equal certainty when the ear, eye, and nose are closed. Hence naturalists have ascribed a sixth sense to these animals. It is probably analogous to that of touch. The nerves of the wing are large and numerous, and distributed in a minute plexus between the integuments. The impulse of the air against this part may possibly be so modified by the objects near which the animal passes, as to indicate their situation and nature.

In geese and ducks the bill is covered with a very sensible skin, supplied with an abundance of nerves from all the three branches of the fifth pair. This apparatus enables them to feel about for their food in mud, where they can neither see nor smell it. None of the amphibia or fishes seem to possess the sense of touch, according to the acceptation stated above.

All the observations and investigations of the structure of the antennæ, those peculiar organs which exist universally in the more perfect insects, and of the use which these animals generally apply them to, lead us inevitably to the conclusion that they really are proper organs of touch, by which the animal examines and explores surrounding objects. Such organs are particularly necessary to insects, on account of the insensibility of their external coat, which is generally of a horny consistence, and also from their eyes being destitute in most instances of the power of motion.

TONGUE.

Most of the herbivorous mammalia, particularly among the bisulca, have their tongue covered with a firm and thick cuticular coat, which forms numberless pointed papillæ directed backwards. These must assist, according to their consistence and direction, at least in the animals of this country, in tearing up the grass. Animals

of the cat kind have their tongue covered with sharp and strong prickles, which must enable the animal to take a firm hold. Similar pointed processes are found in some other animals; as in the bat kind and the opossum.

There seems to be no doubt that in all the mammalia, which we have now considered, the tongue is an organ of taste, at least towards its anterior part.

The toothless animals, on the contrary, as the ant-eater and manis, which swallow their aliment whole, have a worm-like tongue, which is obviously capable of no other use than that of taking their food.

The tongue of the woodpecker has a very singular structure, which admits of its being darted out of the mouth for some inches: it is used for the purpose of catching insects, and is horny and barbed at its extremity. In the frog and chameleon the tongue is also the organ by which the prey is seized. In the former animal it is long, soft, and covered with a glutinous slime. In the quiescent state it lies from before backwards in the mouth, from which it is darted at the prey, consisting of insects, which become entangled by the viscid fluid. The tongue of the chameleon displays a very curious mechanism. It is contained in a sheath at the lower part of the mouth; and has its extremity covered with a glutinous secretion. It admits of being projected to the length of six inches, and is used in this manner by the animal in catching its food, which consists of flies, &c. It is darted from the mouth with wonderful celerity and precision, and the viscous secretion on its extremity entangles the small animals which constitute the food of the chameleon.

ORGAN OF SMELLING.

Two remarkable instances of anomalous structure in parts connected with the nose occur in the proboscis of the elephant, and the blowing holes of the cetacea. The former organ consists of two canals, separated from each other by an intervening partition. Innumerable muscular fasciculi, running in two directions, occupy the space between these and the integuments. There are fibres of a transverse course, passing like radii from the canals to the integuments, and others, which run in a more longitudinal direction, but have their extremities turned inwards. The former extend the trunk, without causing any contraction of the canals; the latter bend or contract it; and both tend to bestow on it that wonderful mobility, which it possesses in every direction.

The more longitudinal fibres are divided at short intervals by tendinous intersections, which enable the animal to bend any part of the organ, and to give it any requisite degree of curvature. The same structure will confer a power of bending different parts of the trunk in opposite directions; indeed there is no kind of curvature which may not be produced by these longitudinal fibres. These fasciculi occupy the external surface of the organ. The transverse fibres are not all arranged like radii round the canals; but some pass across from right to left, and must therefore affect the diameter of those tubes by their action. The whole of these muscular fasciculi are surrounded and connected together by a white, uniform, adipous substance. The transverse ones are not more than a line in thickness. If the number of these which appears on a transverse section be ascertained, and if those portions of the longitudinal fasciculi, which pass from one tendon to another, be reckoned as separate muscles (for they must have a separate power of action) the whole trunk will contain about thirty or forty thousand muscles, which will account satisfactorily for the wonderful variety of motions which this admirable organ can execute, and for the great power which it is capable of exerting.

The blowing-hole of the whales serves as well for respiration as for the rejection of the water which enters with the food. In consequence of its situation at the top of the head, it is easily elevated beyond the surface of the sea, while the mouth is usually entirely under water.

The opening in the bones of the head is divided into two by a partition of bone; and is furnished with a valve opening outwards. On the outside of this opening are two membranous bags, lined with a continuation of the integuments, and opening externally. The water, which the animal wishes to discharge, is thrown into the fauces, as if it were to be swallowed; but its descent into the stomach is prevented by the contraction of the circular fibres of the œsophagus. It therefore elevates the valve placed at the entrance of the blowing holes, and distends the membranous bag, from which it is forcibly expelled by surrounding muscular fibres.

This apparatus occupies the situation, which in other mammalia is filled by the nose; which organ, together with the si-

nuses of the head, the olfactory nerve, &c. is entirely wanting in these animals.

ORGAN OF HEARING.

Some Mammalia have not an external ear; particularly such as live in the water, or under ground.

Most quadrupeds have a peculiar hemispherical bony cavity, communicating with the tympanum, and seeming to hold the place of mastoid cells.

The ornithorhynchus, whose structure is in every respect so anomalous, has only two ossicula auditus.

The cochlea, which belongs exclusively to the Mammalia, has in some cases one turn more than in man.

Whales have an organ of hearing, but the parts are very small.

Birds have no external ear; only a single ossiculum auditus; and a short, obtuse, hollow, bony process, instead of cochlea.

Reptiles have membranous semicircular canals and vestibulum; generally a single ossiculum auditus resembling that of birds; and in some instances, a tympanum and membrana tympani level with the surface of the body.

Fishes have a membranous vestibulum and canals; but no external organs.

THE EYE.

A sensibility to the impressions of light is common to all those animals, which in a natural state are exposed to this element: it appears at least very evidently to exist in some of the most simple zoophytes, as the armed polypes (hydra): but the power of perceiving the images of external objects is confined to those who are provided with eyes for their reception. Nature has bestowed on some species even of red-blooded animals, a kind of rudiment of eyes, which have not the power of perceiving light: as if in compliance with some general model for the bodily structure of such animals. This circumstance at least has been asserted of the blind rat (marmota typhlus) among mammalia; and of the myxine glutinosa among fishes.

The conjunctiva covering the front of the eye-ball, in the former animal is covered with hair, so that the eye, which is exceedingly small, seems to be completely useless.

Large animals have small eye-balls in proportion to their size: this is very remarkably the case with the whales. Those which are much under ground have the globe also very small; as the mole and shrew: in the former of these instances its existence has been altogether denied; and it is not in fact larger than a pin's head.

The eyes of man and the simiæ are directed forwards: in the latter animals indeed they are placed nearer to each other than in the human subject. The lemur tarsius has them more closely approximated than any other animal. All other Mammalia have these organs separated by a considerable interval, and directed laterally. The same circumstance obtains in birds, with the exception of the owl, who looks straight forwards. They are placed laterally in all reptiles. Their situation varies much in fishes: they look upwards in the uranoscopus: they are both on the same side of the body in the pleuronectes; but in general their direction is lateral.

The form of the globe varies according to the medium, in which the organ is to be exerted. In man and the mammalia, it deviates very little from the spherical figure. In fishes it is flattened on its anterior part; in birds it is remarkably convex in front, the cornea being sometimes absolutely hemispherical. The convexity of the crystalline is in an inverse ratio to that of the cornea. Thus in fishes it is nearly spherical, and projects through the iris, so as to leave little or no room for aqueous humour: the cetacea, and those quadrupeds and birds which are much under water, have this part of the same form. The aqueous humour being of the same density with the medium in which these animals are placed, would have no power of refracting rays of light, which come through that medium: its place is supplied by an increased sphericity of the lens. In birds these circumstances are reversed: they inhabit generally a somewhat elevated region of the atmosphere, and the rays which pass through this thin medium, are refracted by the aqueous humour which exists in great abundance. Man, and the mammalia, which live on the surface of the earth, hold a middle place between these two extremes.

The inner surface of the choroid coat, which in man is black throughout, is coloured very beautifully on the temporal side of the eye in most quadrupeds, and this part is called the tapetum.

The pigmentum nigrum is entirely deficient in the eye of the white rabbit, white ferret, &c. as well as in the variety of the human race called the albino.

The quadrumana alone possess the foramen centrale of the retina, besides man.

Most mammalia possess a membrana nictitans, or third eyelid, behind which the eyeball can be drawn, when offended by any extraneous matter.

Birds are distinguished by having a bony ring, composed of numerous flat and overlapping thin plates, in the substance of the sclerotica, at its anterior part.

Another great peculiarity consists in the marsupium or pecten, which appears as a large folded process of the choroid, coming through the retina at the back of the eye, and running in the substance of the vitreous humour towards the crystalline lens, which it does not quite reach.

The third eyelid, or membrana nictitans of birds, is a thin semi-transparent fold of the conjunctiva; which, in the state of rest, lies in the inner corner of the eye, with its loose edge nearly vertical, but can be drawn out so as to cover the whole front of the globe. By this, according to Cuvier, the eagle is enabled to look at the sun.

It is capable of being expanded over the globe of the eye by the combined action of two very singular muscles, which are attached towards the back of the sclerotica. One of these, which is called from its shape the quadratus, arises from the upper and back part of the sclerotica; its fibres descend in a parallel course towards the optic nerve, and terminate in a semicircular margin, formed by a tendon of a very singular construction; for it has no insertion, but constitutes a cylindrical canal. The second muscle, which is called the pyramidalis, arises from the lower and back part of the sclerotica towards the nose. It gives rise to a long tendinous chord, which runs through the canal of the quadratus, as in a pulley. Having thus arrived at the exterior part of the eyeball, it runs in a cellular sheath of the sclerotica along the under part of the eye, to the lower portion of the loose edge of the membrana nictitans, in which it is inserted.

By the united action of these two muscles, the third eyelid will be drawn towards the outer angle of the eye, so as to cover the front of the globe; and its own elasticity will restore it to its former situation.

Two kinds of eyes, very dissimilar in their structure, are found in insects: one sort is small and simple, (stemmata); the others, which are large, seem to consist of an aggregation of smaller eyes; for their general convexity is divided into an immense number of small hexagonal convex surfaces, which may be considered as so many distinct corneæ. The first kind is found in different numbers in most of the aptera, as also in the larvæ of many winged insects. When these undergo the last or complete metamorphosis, and receive their wings, they gain at the same time the large compound eyes. Several genera of winged insects and aptera (as the larger species of monoculi), have stemmata besides their compound eyes.

The internal structure has hitherto been investigated only in the large polyedrous eyes. The back of the cornea (which is the part divided in front into the hexagonal surfaces, called in French, *facettes*) is covered with a dark pigment: behind this are numerous white bodies, of an hexagonal prismatic shape, and equal in number to that of the facettes of the cornea. A second coloured membrane covers these, and appears to receive the expansion of the optic nerve.

Further investigation is, however, required, in order to shew how these eyes enable the insect to see; and to determine the distinction between two such very different organs.

MUSCLES.

The nature and objects of the present work render it impossible for us to enter into the details of comparative myology; we shall therefore restrain our remarks to one or two subjects.

The differences which we discern in the muscles of the lower extremity between man and the other mammalia, arise out of that characteristic feature which so strikingly distinguishes man from all other animals, *viz.* his erect stature. The most minute investigation of this subject will shew us that the erect position belongs to man only; and thereby confirms the elegant observation of the Roman poet:

Pronaque cum spectent animalia cetera terram,
Os homini sublime dedit; cœlumque tueri
Jussit; et erectos ad sidera tollere vultus.

In order to enable any animal to preserve the erect position, the following conditions are required. 1st. That the parts of the body should be so disposed as to admit of being maintained with ease in a state of equilibrium. 2dly. That the muscles should have sufficient power to correct the deviations from this state. 3dly. That the centre of gravity of the whole body should fall within the space occupied

by the feet; and lastly, That the feet themselves should have a broad surface resting firmly on the ground, and should admit of being in a manner fixed to the earth. All these circumstances are united in the necessary degree in man only.

The broader the surface included by the feet, the more securely will the line of gravity rest within that surface. The feet of man are much broader than those of any animal, and admit of being separated more widely from each other. The sources of the latter prerogative reside in the superior breadth of the human pelvis, and in the length and obliquity of the neck of the femur, which, by throwing the body of the bone outwards, disengage it from the hip-joint.

The whole tarsus, metatarsus, and toes, rest on the ground in the human subject, but not in other animals. The simiæ, and the bear, have the end of the os calcis raised from the surface; while, on the contrary, it projects in man, and its prominent portion has a most important share in supporting the back of the foot. The exterior margin of the foot rests chiefly on the ground in the simiæ; which circumstance leaves them a freer use of their thumb and long toes in seizing the branches of trees, &c.; and renders the organ so much the less adapted to support the body on level ground.

The plantaris muscle, instead of terminating in the os calcis, expands into the plantar fascia in the simiæ; and in other quadrupeds it holds the place of the flexor brevis or perforatus digitorum pedis, passing over the os calcis in such a direction that its tendon would be compressed, and its action impeded, if the heel rested on the ground.

The extensors of the ancle joint, and chiefly those which form the calf of the leg, are very small in the mammalia, even in the genus simia. The peculiar mode of progression of the human subject sufficiently accounts for their vastly superior magnitude in man. By elevating the os calcis they raise the whole body in the act of progression; and, by extending the leg on the foot, they counteract that tendency which the weight of the body has to bend the leg in standing.

The thigh is placed in the same line with the trunk in man; it always forms an angle with the spine in animals, and this is often even an acute one. The extensors of the knee are much stronger in the human subject than in other mammalia, as their double effect of extending the leg on the thigh, and of bringing the thigh forwards on the leg, forms a very essential part in the human mode of progression.

The flexors of the knee are, on the contrary, stronger in animals, and are inserted so much lower down in the tibia (even in the simiæ) than in the human subject, that the support of the body on the hind legs must be very insecure, as the thigh and leg form an angle, instead of continuing in a straight line.

The gluteus maximus, which is the largest muscle of the human body, is so small and insignificant in animals, that it may almost be said not to exist. This muscle, which forms the great bulk of the human buttock, extends the pelvis on the thighs in standing; and, assisted by the other two glutei, maintains that part in a state of equilibrium on the lower extremity, which rests on the ground, while the other is carried forwards in progression. The true office of these important muscles does not therefore consist, as it is usually represented, in the common anatomical works, in moving the thigh on the pelvis, but in that of fixing the pelvis on the thighs, and of maintaining it in the erect position.

Such then are the supports, by which the trunk of the human body is firmly maintained in the erect position. The properties of the trunk, which contribute to the same end, do not so immediately belong to this article; but may be slightly mentioned to complete the view of the subject. The breadth of the human pelvis affords a firm basis on which all the superior parts rest securely; the same part is so narrow, in other animals, that the trunk represents an inverted pyramid, and there must consequently be great difficulty in maintaining it in a state of equilibrium, if it were possible for the animal to assume the erect position. In those instances where the pelvis is broader, the other conditions of the upright stature are absent: the bear, however, forms an exception to this observation, and consequently admits of being taught to stand and walk erect, although the posture is manifestly inconvenient and irksome to the animal.

The perpendicular position of the vertebral column under the centre of the basis cranii, and the direction of the eyes and mouth forwards would be as inconvenient to man, if he went on all-fours; as they are well adapted to his erect stature. In the

former case he would not be able to look before him; and the great weight of the head, with the comparative weakness of the extensor muscles, and the want of ligamentum nuchæ would render the elevation of that organ almost impossible.

When quadrupeds endeavour to support themselves on the hind extremities; as, for instance, for the purpose of seizing any objects with the fore feet, they rather sit down than assume the erect position. For they rest on the thighs as well as on the feet, and this can only be done where the fore part of the body is small, as in the simiæ, the squirrel, &c.; in other cases, the animal is obliged also to support itself by the fore feet, as in the dog, cat, &c. The large and strong tail in some instances forms as it were a third foot, and thereby increases the surface for supporting the body, as in the kanguroo and the jerboa.

Various gradations may be observed in the mammalia, connecting man to those animals which are strictly quadrupeds. The simiæ, which are by no means calculated for the erect position, are not, on the other hand, destined like the proper quadrupeds to go on all-fours. They live in trees, where their front and hind extremities are both employed in climbing, &c.

The true quadrupeds have the front of the trunk supported by the anterior extremities, which are consequently much larger and stronger than in man; as the hind feet of the same animals yield in these respects to those of the human subject. The chest is in a manner suspended between the scapulæ, and the serrati magni muscles, which support it in this position, are consequently of great bulk and strength. When viewed together they represent a kind of girth surrounding the chest.

The chief agents in flying are the muscles, which move the anterior extremities of the bird, and which constitute what in common language is termed the breast of the animal.

Birds possess three pectoral muscles, arising chiefly from their enormous sternum, and acting on the head of the humerus. The first, or great pectoral, weighs of itself more than all the other muscles of the bird together. The keel of the sternum, the fork, and the last ribs, give origin to it; and it is inserted in a rough projecting line of the humerus. By depressing that bone, it produces the strong and violent motions of the wing, which carry the body forwards in flying. The middle pectoral lies under this, and sends its tendon over the junction of the fork, with the clavicle and scapula, as in a pulley, to be inserted in the upper part of the humerus; which bone it elevates. By this contrivance of the pulley, the elevator of the wing is placed at the under surface of the body. The third, or lesser pectoral muscle, has the same effect with the great pectoral, in depressing the wing.

One of the flexor tendons of the toes of birds, (produced from a muscle which comes from the pubis) runs in front of the knee; and all these tendons go behind the heel: hence the flexion of the knee and heel produces mechanically a bent state of the toes, which may be seen in the dead bird; and it is by means of this structure that the bird is supported, when roosting, without any muscular action.

This circumstance of the flexion of the toes accompanying that of the other joints of the lower extremity of birds, was long ago observed by Borelli, and attributed by him to the connection which the flexors of the toes have with the upper parts of the limb, by which they are mechanically stretched, when the knee is bent. This explanation has been controverted by Vicq d'Azyr, and others, who have referred the effect to the irritability of the muscles. The opinion of Borelli appears, notwithstanding, to be well founded; for not only the tendon of the accessory flexor passing round the knee, but the course of the flexor tendons over the heel, and along the metatarsus, must necessarily cause the contraction of the toes when either of these joints is bent; and if the phenomenon was not produced on mechanic principles, it would be impossible for birds to exhibit it during sleep, which they do, or to prove the effect on the limb of a dead bird, than which nothing is more easy. The utility of this contrivance is great in all birds, but particularly so in the rapacious tribe, which, by this means, grasp their prey in the very act of pouncing on it; and it is still more necessary to those birds which perch or roost during their sleep, as they could not otherwise preserve their position, when all their voluntary powers are suspended.

URINARY ORGANS.

The structure of the kidney in the mammalia displays two very opposite varieties, which may be called the simple and the conglomerated kidneys. In the former there is a single papilla, which is surround-

ed by an exterior crust of cortical substance. This is the case in all the feræ, and in many rodentia. The other kind of kidney consists of an aggregation of small kidneys, connected by cellular substance. It appears that this form of the gland is found in all those mammalia which either live in or frequent the water. I have observed it in the seal and porpoise, where the small kidneys are extremely numerous, and send branches to the ureter without forming a pelvis. Mr. Hunter states that it belongs to all the whales. ("Philos. Transact. 1807, pt. 2.") The otter has the same structure; but its small kidneys are not so numerous as in the animals above-mentioned. ("Home, of the sea-otter, (lutra marina), Philos. Trans. 1796, pt. 2.") It is remarkable that the brown bear (ursus arctos), which lives on land, should have this structure as well as the white polar bear (ursus maritimus), which inhabiting the coasts and floating ice of the northern regions, spends much of its time in the water. Mr. Hunter concludes, that it is because nature wishes to preserve an uniformity in the structure of similar animals. But the badger, (ursus meles), which is a very similar animal, has the uni-lobular kidney. The number of small kidneys in the bear is 50 or 60, and it appears that each consists of two papillæ.

The kidneys of birds form a double row of distinct, but connected glandular bodies, placed on both sides of the lumbar vertebræ, in cavities of the ossa innominata. The urinary bladder does not exist in this whole class, and the ureters open into the cloaca.

Animals of the genus testudo and rana have a large bladder in the situation of the urinary receptacle of other animals. This is double in many of the frogs properly so called. These bags are represented both by Blumenbach and Cuvier as urinary bladders; but Townson has already shewn, that in the frog and toad they have no connection with the ureters, which open at the back of the rectum, while those receptacles terminate on the front of the intestine. ("Tracts and Observations," p. 66. fig. 3). The writer of this article has observed the same structure in a male and female tortoise.

ORGANS OF GENERATION.

The nature of generation, which is the greatest mystery in the economy of living bodies, is still involved in impenetrable obscurity. The creation of a living body, that is, its formation by the union of particles suddenly brought together, has not hitherto been proved by any direct observation. The comparison of this process to that of crystallization is founded in a false analogy: crystals are formed of similar particles attracting each other indifferently, and agglutinated by their surfaces, which determine the order of their arrangement: living bodies, on the contrary, consist of numerous fibres or laminæ of heterogeneous composition, and various figures, each of which has its peculiar situation in relation to the other fibres and laminæ. Moreover, from the instant in which a living body can be said to exist, however small it may be, it possesses all its parts; it does not grow by the addition of any new laminæ, but by the uniform or irregular developement of parts which existed before any sensible growth.

The only circumstance common to all generation, and consequently, the only essential part of the process, is, that every living body is attached at first to a larger body of the same species with itself. It constitutes a part of this larger body, and derives nourishment for a certain time from its juices. The subsequent separation constitutes birth; and may be the simple result of the life of the larger body, and of the consequent developement of the smaller, without the addition of any occasional action.

Thus the essence of generation consists in the appearance of a small organised body in or upon some part of a larger one; from which it is separated at a certain period in order to assume an independent existence.

All the processes and organs, which co-operate in the business of generation in certain classes, are only accessory to this primary function.

When the function is thus reduced to its most simple state, it constitutes the gemmiparous, or generation by shoots. In this way the buds of trees are developed into branches, from which other trees may be formed. The polypes (hydra) and the sea-anemones (actinia) multiply in this manner; some worms are propagated by a division of their body, and must therefore be arranged in the same division. This mode of generation requires no distinction of sex, no copulation, nor any particular organ.

Other modes of generation are accomplished in appropriate organs: the germs appear in a definite situation in the body, and the assistance of certain operations is

required for their further developement. These operations constitute fecundation, and suppose the existence of sexual parts; which may either be separate or united in the same individual.

The office of the male sex is that of furnishing the fecundating or seminal fluid; but the manner in which that contributes to the developement of the germ, is not yet settled by physiologists. Some, forming their opinions from the human subject and the mammalia, where the germs are imperceptible before fecundation, suppose that these are created by the mixture of the male fluid with that which they suppose to exist in the female; or that they pre-exist in the male semen, and that the female only furnishes them with an abode. Others consult the analogy of the other classes of animals and of plants. In several instances, particularly in the frog, the germ may be clearly recognised in the ovum, before fecundation: its pre-existence may be concluded in other cases from the manner in which it is connected to the ovum when it first becomes visible; for it is agreed on all sides that the ovum exists in the female before fecundation, since virgin hens lay eggs, &c. From such considerations these physiologists conclude, that the germ pre-exists in all females, and that the fecundating liquor is a stimulus which bestows on it an independent life, by awakening it, in a manner, from the species of lethargy in which it would otherwise have constantly remained.

The origin of the germs, and the mode of their existence in the female, whether they are formed anew by the action of life, or are pre-existent, and inclosed within each other; or whether they are disseminated, and require a concourse of circumstances to bring them into a situation favourable for their developement, are questions which, in the present state of our knowledge, it is utterly impossible for us to decide. These points have for a long time been agitated by physiologists; but the discussion seems now to be abandoned by universal consent.

The combination of the sexes, and the mode of fecundation are subject to great variety. In some instances they are united in the same individual, and the animal impregnates itself. The acephalous mollusca and the echinus exemplify this structure. In others, although the sexes are united in each individual, an act of copulation is required, in which they both fecundate and are fecundated. This is the case with the gasteropodous mollusca, and several worms. In the remainder of the animal kingdom the sexes belong to different individuals.

The fecundating liquor is always applied upon or about the germs. In many cases the ova are laid before they are touched by the semen; as in some fishes of the bony division, and the cephalopodous mollusca. Here, therefore, impregnation is effected out of the body; as it is also in the frog and toad. But in the latter instances the male embraces the female, and discharges his semen in proportion as she voids the eggs. In most animals the seminal liquor is introduced into the body of the female, and the ova are fecundated before they are discharged. This is the case in the mammalia, birds, most reptiles, and some fishes; in the hermaphrodite gasteropodous mollusca, in the crustacea and insects. The act by which this is accomplished, is termed copulation.

In all the last mentioned orders ova may be discharged without previous copulation, as in the preceding ones. But they receive no further developement; nor can they be fecundated when thus voided.

The effect of a single copulation varies in its degree; it usually fecundates one generation only; but sometimes, as in poultry, several eggs are fecundated; still, however, they only form one generation.

In a very few instances one act of copulation fecundates several generations, which can propagate their species without the aid of the male. In the plant-louse (aphis) this has been repeated eight times; and in some monoculi twelve or fifteen times.

When the germ is detached from the ovary, its mode of existence may be more or less complete. In most animals it is connected, by means of vessels, to an organised mass, the absorption of which nourishes and developes it until the period of its birth. It derives nothing, therefore, from the body of the mother, from which it is separated by coverings varying in number and solidity. The germ, together with its mass of nourishment, and the surrounding membranes, constitutes an egg or ovum; and the animals which produce their young in this state, are denominated oviparous.

In most of these the germ contained in the egg is not developed until that part has quitted the body of the mother, or has been laid; whether it be necessary that it should be afterwards fecundated, as in many fishes, or require only the application of artificial heat for its incubation, as in birds

or that the natural heat of the climate is sufficient, as in reptiles, insects, &c. These are strictly oviparous animals.

The ovum, after being fecundated, and detached from the ovarium, remains in some animals within the body of the mother, until the contained germ be developed and hatched. These are false viviparous animals, or ovo-viviparous. The viper and some fishes afford instances of this process.

Mammalia alone are truly viviparous animals. Their germ possesses no provision of nourishment, but grows by what it derives from the juices of the mother. For this purpose it is attached to the internal surface of the uterus, and sometimes by accident to other parts, by a kind of root or infinite ramification of vessels called a placenta. It is not, therefore, completely separated from the mother by its coverings. It does not come into the world until it can enjoy an independent organic existence. The mammalia cannot, therefore, be said to possess an ovum in the sense which we have assigned to that term.

From the above view of the subject, generation may be said to consist of four functions, differing in their importance, and in the number of animals to which they belong.

1st. The production of the germ, which is a constant circumstance; 2dly, fecundation, which belongs only to the sexual generation; 3dly, copulation, which is confined to those sexual generations, in which fecundation is accomplished within the body.

Lastly, uterogestation, which belongs exclusively to viviparous generation.

The testes, and sometimes the vesiculæ seminales and prostate vary most remarkably in their magnitude in such animals as have a regular rutting season. They are very diminutive at other periods of the year, but swell at that particular time to a comparatively vast magnitude. This change is particularly observable in the testes of the mole, sparrow, and frog.

We may mention here, in a cursory and general manner, the peculiar organs possessed by the males of some species for the purpose of holding the female during the act of copulation. Of this kind are, the spur on the hind-feet of the male ornithorhynchus; the rough black tubercle formed in the spring season on the thumb of the common frog; the two members, formed of bones articulated to each other, near the genitals of the male torpedo and other cartilaginous fishes; the forceps on the abdomen of the male dragon-fly, &c.

A scrotum belongs to the mammalia only; and is not found in all these. The aquatic genera, those which live under ground, and others want it.

The testes remain constantly in the abdomen in the ornithorhynchus, the elephant, the amphibious mammalia, and the cetacea. Some animals have the power of protruding them from the abdomen, and retracting them again into the cavity; as the bats, mole, hedgehog, and shrew, besides several of the rodentia. They are thrust out of the cavity, particularly at the rutting season.

The tunica vaginalis exists constantly in the mammalia. As the horizontal position of the body obviates the danger of herniæ, the cavity of this membrane communicates by means of a narrow canal with the abdomen, in such animals as have the testes remaining constantly in the scrotum.

In some species, where the act of copulation requires a longer portion of time, as in the dog, badger, &c. the corpus spongiosum of the glans, and of the posterior part of the penis, swells during the act much more considerably than the rest of the organ, and thus the male and female are held together during a sufficient space of time for the discharge of the seminal fluid.

Several species of mammalia, both among those which possess no vesiculæ seminales, and thereby require a longer time for completing the act of copulation, and in such as are not distinguished by this peculiarity, possess a peculiar bone in the penis, generally of a cylindrical form, but sometimes grooved. This is the case with some of the simiæ, most of the bat-kind, the hamster and several others of the mouse-kind, the dog, bear, badger, weasel, seal, walrus, &c.

In most of the mammalia the urethra runs on to the end of the glans, and forms a common passage for the urine, prostatic liquor and semen. In some few species, the passage which conducts the two former fluids, is distinct from that of the seminal liquor. The bifid fork-like glans of the opossum has three openings, one at the point of bifurcation for transmitting the urine; and two for the seminal fluid at the two extremities of the glans. The short urethra of the ornithorhynchus paradoxus opens directly into the cloaca, and the large penis of the animal serves merely to

conduct the seminal fluid. It divides into two parts at its extremity, and each of these is furnished with sharp papillæ, which are perforated for the passage of the semen. A similar structure obtains in the ornithorhynchus hystrix, where the penis divides into four glandes.

In some species of the cat-kind the glans is covered with retroverted papillæ, which, as these animals have no vesiculæ seminales, may enable the male to hold the female longer in his embraces.

Lastly, it deserves to be mentioned, that in some mammalia, the male penis, while unerected, is turned backwards; so that the urine is voided in the male in the same direction as in the female. The hare, lion, and camel, afford instances of this structure. But the statement which has been so often repeated since the time of Aristotle, that these retromingentia copulate backwards, is erroneous.

BIRDS.

The testes, which lie near the kidnies, and the ductus deferentes, are the only male organs which are constantly found in the whole class.

In a very few instances, as in the cock, the last mentioned canals terminate in a dilated part, which has been considered analogous to the vesiculæ seminales. Instead of a penis, most birds have in the cloaca two small papillæ, on which the seminal ducts terminate. This is the case in the cock, turkey, and pigeon.

Some few species have a simple penis of considerable length, which is ordinarily concealed and retracted within the cloaca; but remains visible externally for some time after copulation. It forms a long worm-shaped tube in the drake, and constitutes a groove in the ostrich, which is visible when the animal discharges its urine.

AMPHIBIA.

The kidney, testes, and epididymis, lie close together in the testudines; but each of the three organs may be distinguished by its peculiar colour and structure on the first view. They appear to have no vesiculæ seminales; none at least could be discovered in a testudo græca, which was lately dissected. The penis on the contrary is very large; and retracted within the cloaca in its ordinary state. Instead of an urethra, this part contains a groove, whose margins approach to each other, when the part is erected, so as to form a closed canal. The glans terminates in an obtuse hook-like point, somewhat resembling the end of the elephant's trunk.

Serpents have long slender testicles; no vesiculæ seminales; but a double penis, each of which has a bifid point covered with sharp papillæ.

FISHES.

The male organs of generation possess very different structures in the different orders of this class. We shall take two species as examples; the torpedo for the cartilaginous, and the carp for the bony fishes.

In the former instance there are manifest testicles, consisting partly of innumerable glandular and granular bodies, and partly of a substance like the soft roe of bony fishes. We find also vasa deferentia, and a vesicula seminalis which opens into the rectum by means of a small papilla.

The soft roe supplies the place of testes in the carp, and most other bony fishes. It forms two elongated flat viscera of a white colour, and irregular tuberculated surface, placed at the sides of the intestines and swimming bladder, so that the left encloses the rectum in a kind of groove. Through the middle of each soft roe passes a ductus deferens, which opens behind into a kind of vesicula seminalis, and this terminates in the cloaca.

FEMALE ORGANS OF GENERATION.

An ovarium is the most essential and universal of all the female parts of generation. In addition to this, those animals which breathe by means of lungs, as well as some fishes, and several white-blooded animals, have also oviducts, (Fallopian tubes, &c.) or canals leading from the ovarium to the uterus: and lastly, those, at least, which are impregnated by a real copulation, possess a vagina, or canal connecting the uterus to the external organs of generation.

In birds all the parts which we have just mentioned are single. Some cartilaginous fishes have two oviducts; beginning, however, by a common opening, and terminating in a simple uterus. The human female, as well as that of many other mammalia, has two ovaria, with an oviduct belonging to each; a simple uterus and vagina. The females of this class in several other instances, possess an uterus bicornis: and in some cases the generative organs are double throughout; that is, there are two

uteri, and, at least for some extent, a double vagina.

Ovaria are found in the females of all animals where the male possesses testicles: but their structure is in general more simple than that of the latter glands, particularly in the first class. These bodies were formerly called the female testicles; but the term ovary is much preferable, as it denotes the function which the parts perform in the animal economy. For, if the office of these bodies be at all dubious, when their structure is considered in man and most of the mammalia; their organization is so evident in the other classes, that no doubt can be entertained respecting their physiology. It is manifest in all these, that the ovaria serve for the growth and preservation of the germs or ova, which exist in these bodies, completely formed before the act of copulation. Analogy leads us to conclude that these bodies have the same office in the mammalia; and thus our explanation and illustration of this most interesting part of physiology, are entirely derived from researches in comparative anatomy.

Of all the external female sexual organs in the mammalia, the clitoris is found the most universally and invariably. It exists even in the whales, and probably is wanting in no other instance than the ornithorhynchus. As its general structure much resembles that of the male penis, it contains a small bone in several species, as the marmota citillus, the racoon, lioness, and sea-otter.

A true hymen, or one at least, which in form and situation resembles that of the human subject, has been observed in no other animal.

The structure and form of the uterus vary very considerably in the mammalia. In no instance does it possess that thickness, nor has its parenchyma that density and toughness, which are observed in the human female. Of those which I have dissected, the simia sylvanus had comparatively the firmest uterus. The two-toed ant-eater came the next in order in this respect. But in the greater number of mammalia, this organ is thin in its coats, resembling an intestine in appearance, and provided with a true muscular covering.

The variations in the form of the unimpregnated uterus may be reduced to the following heads:

1. The simple uterus without horns, (uterus simplex,) which is generally of a pyramidal or oval figure. This is exemplified in those animals, where we have stated that it possesses thick coats. Its circumference in some simiæ presents a more triangular form than in the woman: and towards the upper part, in the neighbourhood of the Fallopian tubes, there is an obscure division into two blind sacs, (as in the gibbon, or long-armed ape): this distinction is more strongly expressed in the lori, (lemur tardigradus,) so as to form a manifest approach to the uterus bicornis.

2. A simple uterus with straight or convoluted horns (uterus bicornis.) They are straight in the bitch, in the bats of this country, in the sea-otter, seal, &c.; somewhat convoluted in the cetacea, mare, and hedge-hog, and still more tortuous in the bisulca.

3. A double uterus, having the appearance of two horns, which open separately into the vagina: this is seen in the hare and rabbit, (uterus duplex.)

4. A double uterus, with extraordinary lateral convolutions, is met with in the opossom and kanguroo, (uterus anfractuosus.)

These various forms undergo different changes in the pregnant state.

The alteration in the simple uterus is, on the whole, analogous to that which occurs in the human female.

The pregnant uterus bicornis suffers a different change in those animals which bear only one at a time, from that which it undergoes in the multipara. The fœtus of the mare is confined in its situation to the proper uterus. In the cow it extends at the same time into one of the horns, which is enlarged for its reception. In those, on the contrary, which bring forth many young at once, as also in the double uterus of the hare and rabbit, both cornua are divided by contracted portions into a number of pouches corresponding to that of the young; and where those horns are straight in the unimpregnated state, as in the bitch, they become convoluted.

The uterus of the opossum and kanguroo suffers the least change from its usual appearance in the impregnated state. For these strange animals bring their young into the world so disproportionately small, that they appear like early abortions.

The passage of the fœtus, in the opossum tribe and the kanguroo, from the cavity of the uterus into the false belly, where it adheres by its mouth to the nipple, presents one of the most singular and

interesting phenomena in the whole circle of comparative anatomy. Physiologists have not yet ascertained, whether the embryo possesses, at any period, a connection with the uterus similar to that which is observed in the other mammalia: but it appears very probable, that the processes, which follow the passage of the ovum from the ovarium, are entirely different in these animals, from those which take place in the other mammalia. Neither has the precise period, at which the fœtus enters the false belly been hitherto shewn.

The following statement of the subject, as far as it is at present known, is derived from Mr. Home's paper. (Phil. Trans. 1795.)

The uterus and lateral canals, in their pregnant state, are distended with a very adhesive jelly of a bluish white colour; which also fills the oval enlargements of the Fallopian tubes.

"In the cavity of the uterus," says Mr. Home, "I detected a substance which appeared organized; it was enveloped in the gelatinous matter, and so small as to make it difficult to form a judgment respecting it; but when compared with the fœtus after it becomes attached to the nipple, it so exactly resembled the backbone with the posterior part of the skull, that it is readily recognized to be the same parts in an earlier stage of their formation."

This substance has been represented in a plate; but the engraving does not, in our opinion, possess the slightest similitude to the parts mentioned by Mr. Home.

The size of the fœtus at the time it leaves the uterus is not yet ascertained. The smallest, which has been hitherto found in the false belly, weighed twenty-one grains; and was less than an inch in length. In another instance it was "thirty-one grains in weight from a mother of fifty-six pounds. In this instance the nipple was so short a way in the mouth, that it readily dropped out, we must therefore conclude that it had been very recently attached to it.

"The fœtus at this period had no navel string, nor any remains of there ever having been one; it could not be said to be perfectly formed, but those parts which fit it to lay hold of the nipple were more so than the rest of the body. The mouth was a round hole, just enough to receive the point of the nipple; the two fore-paws, when compared to the rest of the body, were large and strong, the little claws extremely distinct; while the hind-legs, which are afterwards to be so very large, were both shorter and smaller than the fore ones."

"The mode in which the young kanguroo passes from the uterus into the false belly, has been matter of much speculation; and it has even been supposed that there was an internal communication between these cavities; but after the most diligent search, I think I may venture to assert that there is no such passage. This idea took its rise from there being no visible opening between the uterus and vagina in the unimpregnated state; but such an opening being very apparent, both during pregnancy and after parturition, overturns this hypothesis; for we cannot suppose that the fœtus, when it has reached the vagina, can pass out in any other way than through the external part." This passage will be facilitated by the power which the animal possesses of drawing down the false belly to the vulva, which has naturally a considerable projection.

The female organs of generation of birds consist of an ovarium, and an oviduct, which opens into the cloaca. Its aperture is placed towards the left of that organ. The tube itself is convoluted, somewhat like an intestine. Its inner coat is furnished with numerous papillæ. Its diameter is the most considerable at the cloaca, from which it gradually diminishes. It opens towards the abdomen by an expanded orifice, called the infundibulum; which is analogous to the fimbriated orifice of the Fallopian tube.

The ovarium, resembling in its appearance a bunch of grapes, lies under the liver, and contains in a young laying hen about five hundred yolks, varying in size from a pin's head, to their perfect magnitude: the largest always occupy the external circumference of the part. Each yolk is inclosed in a membrane (calyx) which is joined to the ovarium by means of a short stalk or pedicle (petiolus.) A white shining line forms on the calyx when the yolk has attained its complete magnitude. The membrane bursting in this part, the contained yolk escapes, and is taken up by the infundibulum in a manner which we cannot easily conceive. It then passes along the oviduct, and acquires in its passage the white and shell. The calyx, on the contrary, remains connected to the ovarium; but it contracts and diminishes in size, so that in old hens, which have done laying, the whole internal organs of generation nearly disappear.

AMPHIBIA.

The tortoise has a manifest clitoris lying in the cloaca. The oviduct and ovarium have on the whole much analogy with those of birds; but all these parts are double, and have two openings into the cloaca.

The frogs of this country have a large uterus, divided by an internal partition into two cavities, from which two long convoluted oviducts arise, and terminate by open orifices at the sides of the heart. The ovaria lie under the liver, so that it is difficult to conceive how the ova get into the above mentioned openings. The uterus opens into the cloaca.

The toads have not the large uterus; but their oviducts terminate by a common tube in the cloaca.

The lizards of this country have on the whole a similar structure to that of the last mentioned animals. Their oviducts are larger, but shorter, and the ovaria contain fewer ova.

Female serpents have double external openings of the genitals for the reception of the double organs of the male. The oviducts are long and much convoluted. The ovaria resemble rows of beads composed of yellow vesicles.

FISHES.

We shall take the torpedo and the carp as examples of the two chief divisions of the class, as we did in speaking of the male organs.

In the former fish there are two uteri, communicating with the cloaca by means of a common vagina. The oviducts form one infundibulum, which receives the ova as they successively arrive at maturity. These are very large in comparison with those of the bony fishes. The yolk, in its passage through the oviduct, acquires its albumen, and shell. The latter is of a horny consistence, and is known by the name of the sea-mouse. It has an elongated quadrangular figure, and its four corners are curved and pointed in the skate, while they form horny plaited eminences in the sharks. The secretion of the albumen, and the formation of the shell are performed by the papillous internal surface of the duct; and chiefly by two glandular swellings which appear towards its anterior extremity in the summer months, while the eggs are being laid.

The structure is much more simple in the carp, and probably also in the other oviparous bony fishes. The two roes occupy the same position as the soft roe of the male does. They are placed at the side of the intestines, liver, and swimming bladder, as far as the anus. They consist of a delicate membrane inclosing the ova, which are all of one size, and extremely numerous (more than 200,000 in the carp); and terminate by a common opening behind the anus.

The immense number of ova contained in the ovaria of fishes, accounts to us satisfactorily for the astonishing multitudes in which some species are formed. In a perch weighing one pound two ounces, there were 69,216 ova in the ovarium; in a mackarel of one pound three ounces, 129,200; in a carp of eighteen inches, Petit found 342,144; and in a sturgeon of one hundred and sixty pounds, there was the enormous number of 1,467,500.

EMBRYO OF THE MAMMALIA.

The mode of connexion of the pregnant uterus with the membranes of the ovum, and thereby, with the embryo itself, display three chief differences in the various mammalia.

Either the whole external surface of the ovum adheres to the cavity of the uterus, or the connection is effected by means of a simple placenta, or by more numerous small placentæ (cotyledons).

The first kind of structure is observed in the sow, and is still more manifest in the mare. In the latter case, the external membrane of the ovum, the chorion may be said to form a bag-like placenta. Numerous and large branches of the umbilical vessels ramify through it, particularly in the latter half of the period of pregnancy; and its external surface is covered with innumerable flocculent papillæ, which connect it to the inside of the uterus.

In those animals of this class, where the embryo is nourished by means of a placenta, remarkable varieties occur in the several species; sometimes in the form and successive changes of the part; sometimes in the structure of the organ as being more simple or complicated.

In most of the digitated mammalia, as well as in the quadrumana, the placenta has a roundish form; yet it consists sometimes of two halves lying near together; and in the dog, cat, martin, &c. it resembles a belt (cingulum or zona). Its form in the pole-cat holds the middle between these two structures, as there are two round

masses joined by an intervening narrower portion.

The placenta of the bisulca is divided into numerous cotyledons, the structure of which is very interesting as it elucidates the whole physiology of this organ. The parts designated by this appellation are certain fleshy excrescences (glandulæ uterinæ) produced from the surface of the impregnated uterus, and having a corresponding number of flocculent fasciculi of blood-vessels (carunculæ) which grow from the external surface of the chorion implanted in them. Thus the uterine and fetal portions of the placenta are manifestly distinct from each other, and are easily separable as the fœtus advances to maturity. The latter only are discharged with the after-birth, while the former, or the cotyledons, gradually disappear from the surface of the uterus after it has parted with its contents. The number and form of these excrescences vary in the different genera and species. In the sheep and cow they sometimes amount to a hundred. In the former animal and the goat they are, as the name implies, concave eminences; while on the contrary, in the cow, deer, &c. their surface is rounded or convex.

The trunks of the veins which pass from the placenta or carunculæ, and of the arteries which proceed towards these parts, are united in the umbilical chord, which is longer in the human embryo than in any other animal.

In the foal, as in the child, the chord possesses a single umbilical vein; whilst most other quadrupeds have two, which unite, however, into a common trunk near the body of the fœtus, or just within it.

The amnion, or innermost of the two membranes of the ovum, which belongs to the pregnant woman, as well as to the mammalia, is distinguished in some of the latter, as for instance in the cow, by its numerous blood-vessels; while on the contrary, in the human subject it possesses no discernable vascular ramification.

Between the chorion and amnion there is a part found in most pregnant quadrupeds, and even in the cetacea, which does not belong to the human ovum, *viz.* the allantois or urinary membrane. The latter name is derived from the connection which this part has, by means of the urachus, with the urinary bladder of the fœtus; whence the watery fluid which it contains has been regarded as the urine of the animal. The term allantois has arisen from the sausage-like form which the part possesses in the bisulca and the pig; although this shape is not found in several other genera and species; thus in the hare, rabbit, guinea-pig, &c. it resembles a small flask; and it is oval in the pole-cat. It covers the whole internal surface of the chorion in the solidungula, and therefore incloses the foal with its amnion. It contains, most frequently in these animals (although not rarely in the cow), larger or smaller masses of an apparently coagulated sediment in various forms and number, which has been long known by the singular name of the horse-venom, or hippomanes.

Some orders and genera of mammalia resemble the human subject in having no allantois, as the quadrumana and the hedgehog; nay, in the latter animal, the urinary bladder has no trace whatever of urachus.

ON THE INCUBATED EGG.

The various vital processes of nutrition and formation which are carried on in the fœtus of the mammalia while in its mother's body, and by means of the most intimate connexion with the parent, are effected in the incubated chick by its own powers, quite independently of the mother, and without any extraneous assistance, except that of the atmospheric air and a certain degree of warmth.

The egg is covered, within the shell, by a white and firm membrane (membrana albuminis) which contains no blood-vessels. The two layers of this membrane, which in other parts adhere closely to each other, leave at the large end a space which is filled with atmospheric air.

This membrane includes the two whites of the egg, each of which is surrounded by a delicate membrane. The external of these is the most fluid and transparent; the inner one thicker and more opaque; they may be separated in eggs which are boiled hard.

The internal white surrounds the yolk, which is contained in a peculiar membrane called the yolk-bag. From each end of this proceeds a white knotty body which terminates in a flocculent extremity in the albumen. These are called the chalazæ, or grandines.

A small round milk-white spot, called the tread of the cock (cicatricula, or macula), is formed on the surface of the yolk-bag. It is surrounded by one or more whitish concentric circles (halones, or circuli), the use of which, as well as that of

the cicatricula itself, and of the chalazæ, is not yet ascertained.

We now proceed to notice the wonderful successive changes which go on during the incubation of the egg, and the metamorphoses which are observed both in the general form of the chick and in particular viscera. The periods of these changes will be set down from the hen, as affording the most familiar example. It will be best to give, first, a cursory chronological view of the whole process, and then to make a few remarks on some of the most important parts of the subject.

A small shining spot of an elongated form, with rounded extremities, but narrowest in the middle, is perceived at the end of the first day, not in nor upon the cicatricula, but very near that part on the yolk-bag (nidus pulli; colliquamentum; areola pellucida). This may be said to appear beforehand as the abode of the chick which is to follow.

No trace of the latter can be discerned before the beginning of the second day; and then it has an incurvated form, resembling a gelatinous filament with large extremities, very closely surrounded by the amnion, which at first can scarcely be distinguished from it.

About this time the halones enlarge their circles, but they soon after disappear entirely, as well as the cicatricula.

The first appearance of red blood is discerned on the surface of the yolk-bag towards the end of the second day. A series of points is observed which form grooves; and these, closing, constitute vessels, the trunks of which become connected to the chick. The vascular surface itself is called figura venosa, or area vasculosa; and the vessel, by which its margin is defined, vena terminalis. The trunk of all the veins joins the vena portæ; while the arteries, which ramify on the yolk-bag, arise from the mesenteric artery of the chick.

On the commencement of the third day the newly-formed heart (the primary organ of the circulating process which now commences) is discerned by means of its triple pulsation, and constitutes a threefold punctum saliens. Some parts of the incubated chicken are destined to undergo successive alterations in their form; and this holds good of the heart in particular. In its first formation it resembles a tortuous canal, and consists of three dilatations lying close together, and arranged in a triangle. One of these, which is properly the right, is then the common auricle; the other is the only ventricle, but afterwards the left; and the third is the dilated part of the aorta (bulbus aortæ).

About the same time, the spine, which was originally extended in a straight line, becomes incurvated; and the distinction of the vertebræ is very plain. The eyes may be distinguished by their black pigment, and comparatively immense size; and they are afterwards remarkable in consequence of a peculiar slit in the lower part of the iris.

From the fourth day, when the chicken has attained the length of four lines, and its most important abdominal viscera, as the stomach, intestines, and liver, are visible, (the gall bladder, however, does not appear till the sixth day), a vascular membrane (chorion, or membrana umbilicalis) begins to form about the navel, and increases in the following days with such rapidity, that it covers nearly the whole inner surface of the shell within the membrana albuminis, during the latter half of incubation. This seems to supply the place of the lungs, and to carry on the respiratory process instead of those organs. The lungs themselves begin indeed to be formed on the fifth day; but, as in the fœtus of the mammalia, they must be quite incapable of performing their functions while the chick is contained in the amnion.

Voluntary motion is first observed on the sixth day; when the chick is about seven lines in length.

Ossification commences on the ninth day, when the ossific juice is first secreted, and hardened into bony points (puncta ossificationis.)

These form the rudiments of the bony ring of the sclerotica, which resembles at that time a circular row of the most delicate pearls.

At the same period, the marks of the elegant yellow vessels (vasa vitelli lutea) on the yolk-bag, begin to be visible.

On the fourteenth day, the feathers appear; and the animal is now able to open its mouth for air, if taken out of the egg.

On the nineteenth day it is able to utter sounds; and on the twenty-first to break through its prison, and commence a second life.

We shall conclude with one or two remarks on those very singular membranes, the yolk-bag and chorion, which are so essential to the life and preservation of the animal.

The chorion, that most simple yet most perfect temporary substitute for the lungs, if examined in the latter half of incubation in an egg very cautiously opened, presents, without any artificial injection, one of the most splendid spectacles that occurs in the whole organic creation. It exhibits a surface covered with numberless ramifications of arterial and venous vessels. The latter are of the bright scarlet colour, as they are carrying oxygenated blood to the chick; the arteries on the contrary are of the deep or livid red, and bring the carbonated blood from the body of the animal. Their trunks are connected with the iliac vessels; and, on account of the thinness of their coats, they afford the best microscopical object for demonstrating the circulation in a warm-blooded animal.

The other membrane, the membrana vitelli, is also connected to the body of the chick; but by a twofold union, and in a very different manner from the former. It is joined to the small intestine, by means of the ductus vitello-intestinalis (pedunculus, apophysis); and also by the blood-vessels, which have been already mentioned with the mesenteric artery and vena portæ.

In the course of the incubation the yolk becomes constantly thinner and paler by the admixture of the inner white. At the same time innumerable fringe-like vessels with flocculent extremities of a most singular and unexampled structure, form on the inner surface of the yolk-bag, opposite to the yellow ramified marks above-mentioned, and hang into the yolk. There can be no doubt that they have the office of absorbing the yolk, and conveying it into the veins of the yolk-bag, where it is assimilated to the blood, and applied to the nutrition of the chick. Thus in the chicken, which has just quitted the egg, there is only a remainder of the yolk and its bag to be discovered in the abdomen. These are completely removed in the following weeks, so that the only remaining trace is a kind of cicatrix on the surface of the intestine.

COMPARATIVE *degree*, among grammarians, that between the positive and superlative degrees, expressing any particular quality above or beneath the level of another.

COMPARISON *of ideas*, among logicians, that operation of the mind whereby it compares its ideas one with another, in regard of extent, degree, time, place, or any other circumstance, and is the ground of relations. This is a faculty which the brutes seem not to have in any great degree.

COMPARISON, in rhetoric, a figure that illustrates and sets off one thing, by resembling and comparing it with another, to which it bears a manifest relation and resemblance, as the following figure in Shakspeare:

> "She never told her love,
> But let concealment, like a worm i' the bud,
> Feed on her damask cheek: she pined in thought,
> And sat like Patience on a monument,
> Smiling at Grief."

COMPARTMENT, or COMPARTIMENT, in general, is a design composed of several different figures, disposed with symmetry, to adorn a parterre, a ceiling, &c. A compartment of tiles, or bricks, is an arrangement of them, of different colours and varnished, for the decoration of a building. Compartments, in gardening, are an assemblage of beds, plats, borders, walks, &c. disposed in the most advantageous manner that the ground will admit of. Compartments, in heraldry, are otherwise called partitions.

COMPASS, or *mariner's compass*, an instrument whereby the ship's course is determined. See MAGNETISM.

COMPASS is also an instrument in surveying of land, dialling, &c. whose structure is chiefly the same with that of the mariner's compass; and, like that, consists of a box and needle; the principal difference being this, that instead of the needle's being fitted into the card, and playing with it on a pivot, it here plays alone. See SURVEYING.

COMPASS *dials* are small horizontal dials, fitted in brass or silver boxes for the pocket, to show the hour of the day, by the direction of a needle, that indicates how to place them right, by turning the dial about till the cock or style stand directly over the needle and point to the northward; but these can never be very exact, because of the variations of the needle itself.

COMPASSES, or *pair of compasses*, a mathematical instrument for describing circles, measuring figures, &c. They consist of two sharp-pointed branches or legs of iron, steel, brass, or other metal, joined at top by a rivet, whereon they move as on a centre.

COMPASSES *of three legs* are, setting aside the excess of a leg, of the same structure with the common ones; their use being to

take three points at once, and so to form triangles; to lay down three positions of a map, to be copied at once, &c.

COMPASSES *beam*, consist of a long branch or beam, carrying two brass cursors, the one fixed at one end, the other sliding along the beam, with a screw to fasten it on occasion. To the cursors may be screwed points of any kind, whether steel, for pencils, or the like. It is used to draw large circles, to take great extents, &c. See INSTRUMENTS, *mathematical*.

COMPASSES, *caliber*. See the article CALIBER.

COMPASSES, *clockmakers'*, are joined, like the common compasses; with a quadrant or bow, like the spring compasses; only of different use, serving here to keep the instrument firm at any opening. They are made very strong, with the points of their legs of well-tempered steel, as being used to draw lines on pasteboard or copper.

COMPASSES, *elliptic*, consist of a cross with grooves in it, and an index which is fastened to the cross by means of dove-tails that slide in the grooves; so that when the index is turned about, the end will describe an ellipsis, which is the use of these compasses.

COMPENSATION, in horology, is a contrivance in the pendulum of a clock, by means of which, while the expansion from increase of temperature depresses the centre of gravity of some of the vibrating parts, other parts are made to ascend nearer the centre of suspension, or else to draw up the pendulum, so as to preserve the centre of oscillation of the compound pendulum at an invariable distance; and in consequence to keep all the vibrations to the same time.

Compensation pendulums have the part which expands upwards made either of brass, or zinc, or some very expansible metal, while the descending parts are usually iron or steel, and some of these have leaves or machinery in their construction: in others, the compensation-part does not vibrate, but serves to alter the length of a simple pendulum; and in others a fluid is used, most commonly mercury. See HOROLOGY and PENDULUM.

COMPENSATION *balance*. See HOROLOGY.

COMPLEMENT, in astronomy, the distance of a star from the zenith: or the arch comprehended between the place of the star above the horizon and the zenith.

COMPLEMENT, in geometry, is what remains of a quadrant of a circle, or of 90°, after any certain arch has been taken away from it. Thus, if the arch taken away be 40°, its complement is 50: because $50 + 40 = 90$. The sine of the complement of an arch is called the cosine, and that of the tangent, the co-tangent, &c.

COMPLEMENT *of the course*, in navigation, is the number of points the course wants of 90°, or eight points, *viz.* of a quarter of the compass.

COMPLEMENT *of life*, in the doctrine of annuities, denotes the difference, according to M. De Moivre's hypothesis, between the age of any given life and 86 years. Thus the complement of a life of 45 years is 41: of 30 it is 56. According to this hypothesis, the probabilities of life, through every period of existence, are supposed to decrease in an arithmetical progression, so that out of 86 persons just born, one is supposed to die every year, till at the end of 86 years, which is considered as the utmost limit of human life, the last survivor becomes extinct. On this supposition the number of years that a person has an equal chance of surviving, is made to be the same with the expectation which M. De Moivre finds to be equal to half the complement of life: so that if the age be 4, the expectation will be $\frac{82}{2} = 41$: if the age be 82, the expectation will be $\frac{4}{2} = 2$; while the chance that a child aged 4 survives 41 years is $\frac{41}{82}$, and the chance that a person aged 82 survives 2 years is $\frac{2}{4}$. Since each of these fractions is $= \frac{1}{2}$, it follows that the one has an equal chance of living 41, and the other of living 2 years. But by tables founded on observation, the expectation of these lives are $40\frac{2}{3}$ and $3\frac{1}{2}$, while the chance of the younger living $40\frac{2}{3}$ years is 464, and the chance of the elder living $3\frac{1}{2}$ is 53: that is, in the first instance, the chance is less, and in the second greater, than an even one, that a person lives such a number of years as shall be equal to his expectation, which proves the incorrectness of M. De Moivre's hypothesis.

COMPLEMENTS *in a parallelogram*, are the two smaller parallelograms made by drawing two right lines through a point in the diagonal: and parallel to the side of a parallelogram. In every parallelogram these complements are equal.

COMPLEX *terms, or ideas*, in logic, are such as are compounded of several simple ones.

Complex ideas are often considered as single and distinct beings, though they may be made up of several simple ideas, as a body, a spirit, a horse, a flower : but when several of these ideas of a different kind are joined together, which are wont to be considered as distinct, single beings, they are called a compounded idea, whether these united ideas be simple or complex. Complex ideas, however compounded and recompounded, though their number be infinite, and their variety endless, may be all reduced under these three heads, modes, substances, and relations.

COMPLEX *proposition*, is either that which has at least one of its terms complex, or such as contains several members, as causal propositions ; or it is several ideas offering themselves to our thoughts at once, whereby we are led to affirm the same thing of different objects, or different things of the same object. Thus, "God is infinitely wise, and infinitely powerful." In like manner, in the proposition, "Neither kings nor people are exempt from death."

COMPLEXION, a term technically denoting the temperament, habitude, and natural disposition of the body ; but popularly signifying the colour of the face and skin. Few subjects have engaged the attention of naturalists more than the diversities among the human species, among which that of colour is the most remarkable. The great differences in this respect have given occasion to several authors to assert, that the whole human race have not sprung from one original; but that as many different species of men were at first created as there are now different colours to be found among them. It remains, in reality, a matter of no small difficulty to account for the remarkable variations of colour that are to be found among different nations. Dr. Hunter, who considered the matter more accurately than has commonly been done, determines absolutely against any specific difference among mankind. He introduces his subject by observing, that when the question has been agitated, whether all the human race constituted only one species or not, much confusion has arisen from the sense in which the term species has been adopted. He therefore thinks it necessary to set out with a definition of the term. He includes under the same species all those animals which produce issue capable of propagating others resembling the original stock from whence they sprung. This definition he illustrates by having recourse to the human species as an example. And in this sense of the term he concludes, that all of them are to be considered as belonging to the same species. And as, in the case of plants, one species comprehends several varieties depending upon climate, soil, culture, and similar accidents ; so he considers the diversities of the human race to be merely varieties of the same species, produced by natural causes.

Upon the whole, colour and figure may be styled habits of the body. Like other habits, they are created, not by great and sudden impressions, but by continual and almost imperceptible touches. Of habits, both of mind and body, nations are susceptible as well as individuals. They are transmitted to the offspring, and augmented by inheritance. Long in growing to maturity, national features, like national manners, become fixed only after a succession of ages. They become, however, fixed at last ; and if we can ascertain any effect produced by a given state of weather or of climate, it requires only repetition during a sufficient length of time, to augment and impress it with a permanent character. The sanguine countenance will, for this reason, be perpetual in the highest latitudes of the temperate zone ; and we shall for ever find the swarthy, the olive, the tawny, and the black, as we descend to the south.

COMPOSER, in music, a practical musical author ; so called in contradistinction to one who merely speculates in acoustics, and writes on the laws of harmony and melody, but does not concern himself with their practical application in composition.

COMPOSITE *numbers*, are such as can be measured exactly by a number exceeding unity; as 6 by 2 or 3, or 10 by 5, &c. so that 4 is the lowest composite number. Composite numbers, between themselves, are those which have some common measure besides unity ; as 12 and 15, as being both measured by 3.

COMPOSITE *order*, in architecture, the least of the five orders of columns ; so called because its capital is composed out of those of the other columns, borrowing a quarter round from the Tuscan and Doric, a row of leaves from the Corinthian, and volutes from the Ionic. Its cornice has simple modillions or dentils. See ARCHITECTURE.

COMPOSITION *of ideas*, an act of the mind, whereby it unites several simple

ideas into one conception, or complex idea.

COMPOSITION, in music, the art of disposing musical sounds into airs, songs, &c. either in one or more parts, to be sung by a voice, or played on instruments.

COMPOSITION, in oratory, the coherence and order of the parts of a discourse.

To composition belong both the artful joining of the words, whereof the stile is formed, and whereby it is rendered soft and smooth, gentle and flowing, full and sonorous, or the contrary; and the order, which requires things first in nature and dignity, to be put before those of inferior consideration.

COMPOSITION, in painting, consists of two parts, invention and disposition; the first whereof is the choice of the objects which are to enter into the composition of the subject the painter intends to execute, and is either simply historical or allegorical. The other very much contributes to the perfection and value of a piece of painting.

COMPOSITION, in commerce, a contract between an insolvent debtor and his creditors, whereby the latter accept of a part of the debt in compensation for the whole, and give a general acquittance accordingly.

COMPOSITION, in printing, commonly termed composing, the arranging of several types or letters in the composing-stick, in order to form a line; and of several lines ranged in order in the galley, to make a page; and of several pages to make a form.

COMPOSITION *of motion*, is an assemblage of several directions of motion, resulting from several powers acting in different, though not opposite directions. See MECHANICS.

COMPOSITION *of proportion*, is the comparing the sum of the antecedent and consequent, with the consequent in two equal ratios; as, suppose, $4:8::3:6$, they say, by composition of proportion, $12:8::9:6$.

COMPOST, in husbandry and gardening, several sorts of soils or earthy matter mixed together, in order to make a manure for assisting the natural earth in the work of vegetation, by way of amendment or improvement.

COMPOUND *flower*, in botany, a flower formed of the union of several fructifications, or lesser flowers within a common calyx; each lesser flower being furnished with five stamina, distinct at bottom, but united by the anthers into a cylinder, through which passes a style considerably longer than the stamina, and crowned by a stigma or summit, with two divisions that are rolled backwards. These are the essential characters of a compound flower. Compound flowers which make up four classes in Tourneforts system, are all reduced to the class Syngenesia, which see. See BOTANY.

COMPOUND *interest*. See INTEREST.

COMPOUND *motion*, that affected by the concurring action of several different powers. Thus, if one power act in the direction of, and with a force proportional to the end of a parallelogram, and another act in the direction of, and with a force proportional to its side, the compound motion will be in the direction of, and proportional to, the diagonal of the said parallelogram.

COMPOUND *numbers*, those which may be divided by some other number besides unity without leaving any remainder; such are, 18, 20, &c. the first being measured by the numbers 2, 6, or 9; and the second by the numbers 2, 4, 5, 10.

COMPRESS, in surgery, a bolster of soft linen cloth, folded in several doubles, frequently applied to cover a plaster, in order not only to preserve the part from the external air, but also the better to retain the dressings. See SURGERY.

COMPRESSION, the act of pressing or squeezing some matter, so as to set its parts nearer to each other, and make it possess less space.

Water was, during a very long period, considered as a fluid perfectly unelastic; that is, unyielding, or incompressible; and this opinion was corroborated by an experiment of the Academy del Cimento in Italy. About a century and a half ago the members of that academy endeavoured to ascertain whether water was capable of being compressed in any degree. For this purpose they filled a hollow metallic sphere with that fluid, and stopped the aperture very accurately. This ball then was pressed in a proper machine, but no contraction could be observed, nor, indeed, was the apparatus capable of manifesting small degrees of compression. Hence they concluded that water was not capable of compression. This opinion prevailed until the year 1761, when the ingenious Mr. Canton discovered the compressibility of water, and of other liquids, which he immediately made known to the Royal Society. He took a glass tube, having a ball at one end, filled the ball and part of the tube with water, which he had deprived of air as much as it was in his power; then placed

the glass thus filled under the receiver of an air-pump; and on exhausting the receiver, which removed the pressure of the atmosphere from over the water and the glass vessel which contained it, in consequence of which the water rose a little way into the tube, *viz.* expanded itself. He then placed the apparatus under the receiver of a condensing engine, and on forcing the air into it, which increased the pressure upon the water, a diminution of bulk evidently took place; the water descending a little way within the tube. "In this manner," Mr. Canton says, "I have found by repeated trials, when the heat of the air has been about 50°, and the mercury at a mean height in the barometer, that the water will expand and rise in the tube by removing the weight of the atmosphere, one part in 21740, and will be as much compressed under the weight of an additioual atmosphere. Therefore the compression of water by twice the weight of the atmosphere is one part in 10870." "Water has the remarkable property of being more compressible in winter than in summer, which is contrary to what I have observed both in spirits of wine and oil of olives." By the same means, and in the same circumstances, Mr. Canton ascertained the property of being compressed in some other fluids, and the results are as in the following table:

	Millionth part.
Compression of spirit of wine	66
.... oil of olives	48
.... rain water	46
.... sea water	40
.... mercury	3

COMPTONIA, in botany, so called in honour of Henry Compton, Lord Bishop of London, a genus of the Monoecia Triandria class and order. Essential character: male, ament. calyx two-leaved; corolla none; anthers two-parted. Female ament. calyx six-leaved; corolla none; styles two; nut. ovate. There is but one species, *viz.* C. asplenifolia, fern-leaved Comptonia, a native of North America.

COMPUTATION *of a planet's motion.* See PLANET.

COMPUTATION, in law, is used in respect of the true account or construction of time, so understood as that neither party, to an agreement, &c. may do wrong to the other; and that the determination of time be not left at large, or taken otherwise than according to the judgment and intention of law.

If a lease is ingrossed, bearing date January 1,1808, to have and to hold for three years from henceforth, and the lease is not executed till the second of January; in this case the words from henceforth shall be accounted from the delivery of the deed, and not by any computation from the date. And if the lease be delivered at four o'clock in the afternoon on the said second day it shall end the first day of January, in the third year; the law, in such computations, rejecting all fractions or divisions of the day.

CONCAVE, an appellation used in speaking of the inner surface of hollow bodies, but more especially of spherical ones.

CONCAVE *glasses*, such as are ground hollow, and are usually of a spherical figure, though they may be of any other, as parabolical, &c. All objects seen through concave glasses appear erect and diminished.

CONCENTRATION, in chemistry, the act of increasing the strength of fluids, which are rendered stronger by abstracting a portion of the mere menstruum. This is generally effected by evaporation, where the menstruum is driven off at a lower heat than is required to drive off the substance with which it is united. Thus, dilute sulphuric acid may be considered as a mixture of the real acid with water; and by applying a certain heat the water may be evaporized, leaving the acid behind in a state of concentration. When concentrated as much as possible, its specific gravity is about twice as great as that of water; but it can rarely be obtained denser than 1.85. When concentrated to 2.000 it contains a considerable portion of water, as has been proved by combining it with barytes or potash, in which case water remains behind, and does not enter into the combination. Again, vinegar consists of an acid and water, and brandy of alcohol and water; and in proportion as the acid and alcohol are freed from the water, they are said to be more or less concentrated. This may be performed, (1.) either by simple distillation, in which case the acid or spirit comes over first, leaving the water behind; or, (2.) by exposing the vinegar or brandy to severe frost, when the water will be frozen, and the acid or alcohol will be found in a state of concentration in the middle of the ice; the greater the cold the higher the state of concentration. M. Lowitz has found that the acid, however concentrated, congeals at 22°. Sulphuric acid, on the other hand, exposed to a much less severe cold crystallizes, and to effect this it must not be greatly concentrated. 3. Another mode of concentrating the acetic acid is by distil-

ling acetate of copper reduced to powder in a retort. At first there comes over a liquid nearly colourless, and almost insipid, and afterwards a highly concentrated acid, tinged with green; but being distilled a second time in a moderate heat it is colourless, transparent, exceedingly pungent and concentrated. 4. The most perfect method of obtaining this acid in a concentrated state, was discovered by Mr. Lowitz, of Petersburgh. It is thus: distil a mixture of three parts of acetate of potash, and four parts of sulphuric acid, till the acetic acid has come over into the receiver. To separate it from the sulphuric acid, with which it is slightly contaminated, it must be distilled over a portion of acetate of barytes.

CONCENTRIC, in mathematics, something that has the same common centre with another: it stands in opposition to eccentric. Concentric is chiefly used in speaking of round bodies and figures, or circular and elliptical ones, &c. but may be likewise used for polygons, drawn parallel to each other upon the same centre. The method of Nonius, for graduating instruments, consists in describing with the same quadrant 45 concentric arches, dividing the outermost into 90 equal parts, the next into 89, &c.

CONCEPTION, in logic, is the simple apprehension or perception which we have of any thing, without proceeding to affirm or deny any thing about it. There are rules by which we may guide and regulate our conceptions of things, which is the main business in logic: for most of our errors in judgment, and the weakness, fallacy, and mistakes of our argumentation proceed from the darkness, confusion, defect, or some other irregularity in our conceptions. The rules are these: 1. To conceive of things clearly and distinctly in their own natures. 2. Completely in all their parts. 3. Comprehensively in all their properties and relations. 4. Extensively in all their kinds. 5. Orderly, or in a proper method.

CONCESSION, in rhetoric, a figure whereby something is freely allowed that yet might bear dispute, to obtain something that one would have granted to him, and which he thinks cannot fairly be denied, as in the following concession of Dido, in Virgil:

"The nuptials he disclaims, I urge no more;
Let him pursue the promis'd Latian shore.
A short delay is all I ask him now;
A pause from grief, an interval from woe."

CONCHIUM, in botany, a genus of the Tetrandia Monogynia class and order. Calyx none; petals four, supporting the stamina; stigma turbinate, mucronate; capsule one-celled, two-seeded; seeds winged.

CONCINNOUS, in music, a term generally confined to performance in concert. It applies to that nice discriminating execution in which the band not only gives with mechanical exactness every passage of the composition, but enters into the design or sentiment of the composer, and, preserving a perfect concord and unison of effect, moves as if one soul inspired the whole orchestra.

CONCHOID, in geometry, the name of a curve, given it by its inventor, Nicomedes, and is thus generated.

Draw the right line Q Q (see Plate III. Miscel. fig. 14.) and AC perpendicular to it in the point E; and from the point C draw many right lines C M, cutting the right line Q Q in Q; and make $QM = QN$, $AE = EF$, *viz.* equal to an invariable line: then the curve, wherein are the points M, is called the first conchoid; and the other, wherein are the points N, the second; the right line Q Q being the directrix, and the point C the pole: and from hence it will be very easy to make an instrument to describe the conchoid.

The line Q Q is an asymptote to both the curves, which have points of contrary flection. See ASYMPTOTE. If $QM = AE = a$, $EC = b$, $MR = EP = x$, $ER = PM = y$: then will $a^2 b^2 - 2 a^2 b x + a^2 x^2 = b^2 x^2 - 2 b x^3 + x^4 + x^2 y^2$, and express the nature of the second conchoid; and $x^4 + 2 b x^3 + y^2 x^2 + b^2 x^2 = a^2 b^2 + 2 a^2 b x + a^2 x^2$, the nature of the first; and so both these curves are of the third kind.

This curve was used by Archimedes and other ancients in the construction of solid problems; and Sir Isaac Newton says that he himself prefers it before other curves, or even the conic sections, in the construction of cubic and biquadratic equations, on account of its simplicity and easy description, shewing therein the manner of their construction by help of it.

CONCHOLOGY. The study of shells, or testaceous animals, is a branch of natural history, though not greatly useful in human economy, yet perhaps by the beauties of the subjects it treats of, is adapted to recreate the senses, and insensibly lead to the contemplation of the glory of the Divinity in their creation.

Shells appear to form a part of the creation not immediately subservient to the purposes of human life. This being admitted, still they are a link in the great chain of nature; they constitute a department of rational inquiry worthy the researches of the man of science; and when we consider the amazing diversity of singular and beautiful objects they embrace, are such, we are persuaded, as cannot fail to arrest, in a particular degree, the regard of every common observer.

The term conchology comprehends the study of all animals which have a testaceous covering, whether inhabitants of the marine element, fresh water, or the land. Testaceology is a term synonymous with conchology, but is of later origin and application.

A precise distinction should be drawn between testaceous and crustaceous animals; they are essentially different; though both are protected by a hard exterior shell or crust, in which they are partially or entirely enveloped; and have been indiscriminately confounded together, for that reason, under the vague denomination of shell fish. Some of the old writers distinguish the testacea as a kind of stone-like calcareous covering or habitation, in which the animal, otherwise naked, resides, and from which it can protrude its molluscous arms, or other naked parts of its body, at pleasure. The crustaceous animals of those authors, on the contrary, are not naked, but have every particular limb or part separately covered with the crust, which is thus divided into many joints, insomuch that the whole animal assumes a loricated appearance, as if inclosed in a coat of mail. Among the crustaceous order, the *cancri*, or crabs and lobsters, were included. A better definition may be obtained by attending to the chemical properties of the two substances testaceous and crustaceous. Poli, in his work on the shells of the two Sicilies, demonstrates that testaceous bodies consist of calcareous earth united to a small portion of animal matter or gluten; and Mr. Hatchett, whose experiments on the chemical characters of those bodies are inserted in the Transactions of the Royal Society, draws a striking distinction from analysis between the testaceous and crustaceous bodies, ascertaining the first to consist only of carbonate of lime mixed with gelatinous matter, while in the other the presence of phosphate of lime was detected. The crustaceous body analysed by Mr. Hatchett was the echinus.

All testaceous animals are composed of two parts; one of which, the animal itself, is soft and molluscous; the other, is the shell, or habitation, which is hard, of a stony or calcareous nature, and either partially or entirely covers the animal. The animal is attached to the shell by means of ligaments or muscles.

It was long considered as a matter of dispute among naturalists, whether the arrangement of shells should be constituted from the animals or their habitation. No one can deny, that if we proceed on principles strictly scientific, we must regard them as a department of zoology, and should, on that account, dispose them according to the nature and structure of the animals. But the classification formed from the characters of the shells is universally followed, and we must confess, too, is for many reasons preferable to any other. Neither is it, in the hands of the skilful conchologist, attended with so much indecision as might be generally imagined.

In the first place, among the vast variety of shells hitherto discovered, how small, comparatively, is the number of those whose animal inhabitant is described or known. It is not of species only that we speak, but of whole natural families or genera, not a single species of which has been yet discovered with the animal appertaining; so little are we acquainted with the molluscous orders, or animals inhabiting the shells. Of the shells we daily see in collections few are fished up alive, the far greater number are found on shores, dead or empty. Neither, if it were otherwise, are accurate descriptions of animals whose parts are not easily seen, or anatomical investigations, which are in many cases necessary, within the capacity of every one. Many of their parts, and their respective functions, are not to be ascertained, except by comparative analogy, and which in itself presents an insurmountable difficulty, or a field of critical inquiry so extensive and complicated that few, even with the ability to pursue it with success, could be prevailed upon to devote that attention to the subject which it requires.

Hence it becomes impossible to arrange the far greater number of testaceous productions by the animals; the attempt must ever prove unsuccessful. Our arrangements would be partial, and three-fourths of the

shells known must be either excluded from the system, or be placed at hazard; and of course without order or connection with those whose animals we are acquainted with. The latter are chiefly such as are confined to the coasts of the European seas, and some of the terrestrial and fresh water kinds, which, from their abundance and locality, have obtruded themselves upon the investigations of the naturalist. Even our knowledge of those is exceedingly imperfect.

The best characters, upon which to found all systems of natural history, must be those most obvious and accessible. All ranks of animals, as nearly as can be with convenience, should be arranged by apparent and external characters. While we study shells, without regarding the animal, we are aware they are but considered partially. The animals that inhabit them should guide us in our researches; they alone are the fabricators of the shell, and the shell is only their habitation, to which they give the form, the bulk, hardness, colours, and all the peculiarities of elegance we admire. If we were to examine these new and almost unknown beings, we should discover a number of parts as remarkable for their structure as their functions, and an infinite variety of curious and interesting particulars relative to their general habits and manners of life. It is a subject worthy of the serious contemplation and attention of the naturalist, and should never be neglected when an opportunity offers. But a system of conchology, founded entirely on the structure of the animals, must, probably, ever remain one of the desiderata of natural science.

In the superficial arrangement taken from shells alone we are not exempt from difficulty. Shells vary exceedingly in form and colour in the different stages of their growth, and in this case we should sometimes derive material assistance from our knowledge of the animal. Young shells have been described as specifically distinct from the parent or older shells by many writers. It indeed requires a greater degree of caution in determining the species, nay, even genera, of shells, in the different periods of growth, than may be imagined; of this we could adduce many very remarkable instances, a few it may be necessary to mention, to guard the common observer from forming hasty and erroneous conclusions.

Many of the cyprææ, or cowries, when young, have the appearance of a volute, the thick denticulated fold of the exterior lip being wholly wanting, and the column being only partially plaited as in the true voluta. The young of the alated shells, in general, are destitute of that broad expansive or furcated lip, called the wing. The spires in many of the turreted kinds of shells, when young, are blunt; obtuse, or terminated in a large globular head, exceeding the size of the whorl beneath, but as the shell advances in growth, it developes itself, extending in a spiral direction, and thus in the old shells the number of spires is greater than in the young ones. The variations in the growth of the patella tribe are often so considerable, as to almost defy the critical observer to determine them. Still, however, the conchologist, by the dint of application and nice discrimination, will be at last enabled to fix on certain characters peculiar to every species, and be, by that means, enabled to decide on the species of a shell under every stage of growth.

The primary character must be taken from the shell, because this we are acquainted with, while the animal is oftentimes unknown to us. But the structure of the animal should be regarded in the construction of genera, when it can be ascertained, as a secondary consideration to guide us in the formation of new genera, or in correcting the old, as opportunities of investigating them occur.

Having defined the meaning of a testaceous animal, and endeavoured to prove that the structure of the shell is the most material object to be regarded in a primary view, we shall proceed next to an elementary elucidation of the several parts of which it is composed.

In conchology, as in any other science, the student must necessarily acquire, in the first instance, a distinct knowledge of the terms employed. These, except such as relate to subordinate characters, or specifical distinctions, and which require no explanation in this place, may be simplified and reduced to a small number. In the selection of these terms we can abide by no one particular authority: we must be general, deriving our terms from various sources, or inventing new ones. Hitherto in treating on the different articles of conchology, it has been our aim to adhere as nearly to the authority of Linnæus as possible.

All shells or testaceous bodies hitherto discovered, may be divided into three prin-

cipal tribes, and which, after the Linnæan manner, may be denominated Multivalve, Bivalve, and Univalve.

Any external part of a shell being of a testaceous substance, and either itself, forming a shield or covering for the animal, as in univalves, or in union with another, or others connected by a ligament, cartilage, hinge, teeth, or other fastening, is denominated a valve. The shells, therefore, consisting of a single piece, are called univalves, those of two parts bivalves, and those of many parts multivalves. Between bivalve and multivalve no distinction is drawn, shells consisting of more than two such parts being called multivalve, without any regard to the number. An amendment is proposed by some of the French writers, in a new order under the name of trivalve.

Shells of the simplest form are arranged by some naturalists in the first class, from which they proceed progressively to those possessing the greatest number of valves, and being of the most intricate structure. This is an ancient and very simple mode of arrangement, and has its advocates in the present day. Linnæus reverses this order by beginning with the chiton, lepas, and pholas, which are shells of the multivalve and most complex structure, and ending with those of the simplest form. The former seems most preferable.

Univalve. In the examination of a shell of this order, the contour, or outline, is the first particular to be regarded. By this the conchologist is guided in his definition of simple, spiral, or turbinated shells, (or as the Linnæan school divides shells, univalves with a regular spire, and univalves without a regular spire); discoid, flattened, or turreted shells; those with smooth or uneven anfractus; the ventricose, alated, labiated, rostrated, and many other distinctions, all which strike the eye at the first view. It is indeed, by attending to the contour, that the principal distinctions in shells of this kind are at once perceived, taking into consideration the back and front profile at the same time. Some few shells, as the nautilus pompilius, and others of the same family, have the spire revolving internally, in which the outline offers less assistance in the primary definitions, but the number of such shells is very small. Next to the profile of the shell, the structure of the mouth, the pillar, and expansion of the inner lip, the gutter or canaliculation, and the umbilical opening, and operculum, if any, are to be considered, and, lastly, the work on the outer surface, as well as the colours with which it is embellished.

The base or bottom of the shell we consider that part upon which it rests when supported in an erect position, with the summit or tip of the spire standing vertically. In such shells the tip is called the apex. The course of the spires or wreaths is from the left to right in most spiral shells, some few only being of the reversed or heterostrophous kind, the whorls of which are in a contrary direction. When speaking of the right and left sides of a shell, it should be understood as having the aperture downwards, and it will be then seen that in most shells the aperture or opening is on the left side, *i. e.* facing the right hand of the spectator.

Base, the tip of the salient end of the shell, at the extremity opposite the apex of the spire; in the rostrated kind of univalves it implies the tip of the beak. Some say the shell rests on its base when laid upon a flat surface with the mouth downwards: this is not correct, except in the patella tribe, and some other univalves which have no regular spire, as the dentalium, &c. Apex, the summit of the shell. Front, the face of the shell with the aperture placed directly in front of the observer. Back, that part of the shell which is immediately opposed to the preceding. Sides, those parts seen longitudinally in profile, to the right and left when the shell is viewed either in a front or back position. Body, of the shell, (corpus) the first whorl of the spire at the base. Belly, is to be distinguished from the body as it implies only the convex or swollen part of the first whorl, formed by the convexity of the aperture near the lip. Whorl, denotes one of the wreaths, turns, or evolutions of the shell.

Spire, comprehends, in a general sense, all the whorls of the shell, the first or body wreath excepted. The form of the spire is of great consideration in the definition of shells, as it affords a prominent and distinguished character; it is in general flattish, somewhat depressed or elevated; sometimes convex and slightly pointed; or with the point obtuse; or much elevated and ending in a point; plano-concave, pyramidal, subulate, or truncated. Mr. Adanson observes, that the disposition of the spires varies according to the plane they turn on, which is either horizontal, cylindrical, conic, or ovoid. These he conceives to be the four principal dispositions of the spires, but

admits there are many intermediate formations. The number and form of the spires vary in the same species, in their different growths. Young shells have commonly a less number than the old ones, neither have shells of the same age always the like number of spires, a circumstance attributable to the effects of sickness, or the difference of sex. Thus in some turbinated shells we perceive that the males have the spires less numerous, smaller, and in a more lengthened form than in the females.

Suture of the spire or whorls, is the spiral line which separates the whorls, and which is sometimes sulcated, crenulated, or somewhat projecting.

Pillar or columella, is the inner part of the left lip or column, which runs through the shell, from the lower extremity to the tip of the spire, and from which all the spires take their origin; the columella being situated as nearly as possible in the axis of the shell, and serving as its basis and support throughout. It is generally either flat, grooved, folded, or truncated in that part which is visible at the opening.

Aperture, called in familiar language, the mouth of the shell, is the entrance to the chamber in which the animal resides, and is applicable to the openings of univalve and multivalve shells. The aperture is either entirely open, or closed by the operculum attached to the body of the animal, when the animal retires into its dwelling. This aperture varies in form in different shells, being angular, rounded, semilunar, linear, or otherwise, and sometimes appears double, the inner margin being surrounded by an exterior one.

Lip. The expansion of the exterior part of the aperture constitutes the lip in the labiated shells, and the wing in the alated kinds.

Beak, or rostrum, is that part at the base which extends in a straight or slightly oblique direction from the bottom of the aperture, and is larger or smaller in different families. In the murex haustellum this projection is very conspicuous.

Canal, or gutter, an elongation of the aperture of the shell descending in a groove or gutter-like process. Some kinds of rostrated shells have the canal remarkably conspicuous, forming a sinus from the aperture throughout the whole length of the beak.

Umbilicus, is the opening or perforation in the lower part of the body, or first whorl of many spiral univalves, and is very conspicuous in a number of the trochus and nerita genus in particular. This umbilical perforation runs in a straight line from the base to the summit of the shell, forming throughout a spiral groove or gutter, which is wide at the entrance, and tapers gradually towards the apex. In the Linnæan nerita canrena, the structure of the umbilicus is well displayed, but is still more obvious in the staircase shell, trochus perspectivus. This opening occurs in many shells at the base of the pillar.

Operculum is a testaceous or cartilaginous appendage peculiar in a considerable degree to the univalve tribe of shells, and those only of the spiral or turbinated kinds. This appendage is not connected with the shell, but the animal, and serves like a lid or little door, to protect or close up the aperture of the chamber when the creature retires within its habitation. Shells of this kind are distinguished by the name of cochleæ operculatæ, by some of the elder conchologists. The opercula are often small in comparison to the size of the shell to which they belong; their form varies in different species; and their substance in some of a horny texture, and, in others, testaceous or approaching the nature of stone. Their figure in common is either perfectly round, elliptical, oval, or elongated, and sometimes wrought with spiral work, or concentric lines.

Epidermis is a kind of skin or coating, with which the exterior surfaces of many shells, both of the univalve and bivalve tribe, are covered. It is considered as a sort of periosteum or membrane, designed by nature to defend the shell from accidents and aid their growth, and to prevent other testaceous or marine animals from fixing their habitations on these shells, as they do upon most bodies in the sea, where there is no power of resistance. The epidermis is a genuine covering formed by the animal itself, peculiar to some kinds, and as constantly never observed on others. There is no doubt but the animal to which this sort of covering is peculiar, possesses a proper apparatus for its construction. The structure of this epidermis, it should be added, is very distinct in different shells, consisting in some of a very thin pellucid film, and in others laminated, pilous, velvety, fibrous, or rugged. Few shells, having a rugose surface, are destitute of this external covering or epidermis.

Bivalves, or shells of two valves united by means of a cartilage, hinge, connection

of the teeth, or other process. In order to constitute a bivalve shell, it is only requisite that it be furnished with two connected valves, without regard to their resemblance in form or dimensions. Some of the bivalves have both valves formed alike; in others they differ only in a slight degree, and again in others they are altogether dissimilar. The first of these is well exemplified by the solen genus; in that of the Linnæan tellinæ, we find examples both of the equivalve shells, and those with the valves slightly different: of the last-mentioned kinds we have many, as the ostrea, spondylus, and anomia. Bivalve shells are often much compressed, some are gibbous, and when viewed at the side, or facing the ligament, have a cordated appearance, as in the venus, and the Linnæan chama cor. Shells, having both valves alike, as before observed, are called equivalve. Equilateral valves imply those which have both sides of the same valve alike; as for instance, when a longitudinal line is drawn from the beak to the opposite margin, the space on each side of the line is distinguished by the appellation of the right and left side; and when the form of both those spaces correspond, the shell is equilateral, as in the scallops (ostrea. Linn.): the inequilateral valves are the reverse of this, a line drawn as above described, from the beak to the opposite margin, presenting two sides of a very different shape, as we see in most of the mactra, the donax, and tellina genera, and in the mya truncata especially. Subequilateral shells, or those having the valves nearly equal at both sides, are sufficiently elucidated by shells of the cardium, or cockle genus, which are strictly "bivalvis subæquilatera."

All bivalve shells do not completely close their shells, though most of those before mentioned do so, such as the scallop, the donax, tellina, and cardium: in several other tribes of bivalves, when the shells are shut as closely as their form will allow, they still exhibit a kind of hiatus or gaping, either at the anterior or posterior end, or at both; and in some, when the valves are shut, both the anterior and posterior parts are closed, but an opening appears on one side of the beak; this last-mentioned character is very obvious in chama gigas.

One of the first circumstances to be considered, is, which part of a bivalve shell ought to be deemed the base, because when this is determined, every other part will fall progressively in their relative order under our observation. We name that part of the margin or limb which is situated in a direct line opposite the beak, the base of the shell. Linnæus, in order to establish the characters, and afford some apparent reason at least for the application of the terms he bestows on the different parts of bivalves, reverses this position of the shell, and describes the beaks as the base of the shell. But the fact is, the natural position of the shell is in immediate contradiction to his axiom, for the beaks are always uppermost, being either immediately vertical, or with a slight inclination obliquely, when the animal moves along with its testaceous covering on the back. A solitary example will perhaps occur occasionally, in which the beaks may be considerably inclined when the animal crawls, but none, we believe, are known which open the valves upwards, and proceed with the beaks under the body. The beaks, if only for this reason, are to be considered as the summit, and the margin opposite as the base. Many of the bivalves are destitute of the locomotive power, or at least do not possess it in any material degree.

Summit, a word applied in a general manner to the top or most elevated part of the two protuberances observable in the greater number of bivalves. Da Costo calls that part of the shell, in which the teeth or hinge is placed, the summit or apex; we regard it as the most elevated part of the beaks. Beak, the pointed termination, apex, or tip of the protuberances last-mentioned, and which, in many shells, turn spirally downwards, or obliquely, so that the beak itself is seldom the most elevated part of the shell: though it is so sometimes, as for instance in the mytilus edulis, or common muscle. Sides, the lateral parts of the valves distinguished by the epithet of right and left side; in common language, the two valves of a shell are called the sides, but it is not understood as a term in conchology in this view. Margin, or limb, the whole circumference or outline of the shell, when laid flat down on one valve. Disk, the convex centre of each valve, or exterior surface. Anterior slope, that part of the shell in which the ligament is situated; in the front view of the anterior slope, the beaks fall back, or behind. Posterior slope, that immediately opposed to the former, and in which the beaks of the shell turn forward. Lunule, the lunulated depression below the beaks, either on the anterior or posterior slope,

and sometimes on both; they may be distinguished under the appellation of anterior or posterior lunules, according to the slope in which they are situated. Cartilage of the hinge, called also the ligament of the hinge, the substance of a flexible, fibrous, and somewhat horny nature, by means of which the two valves are united near the beak. Ears, the lateral processes near the beaks, as in the scallop tribe: those occur either on one side, or on both. Ligament perforation, the opening, or aperture, through which the ligature of the animal passes in the anomia genus, by the assistance of which it fastens itself to the rocks, or other bodies; in some it is situated in the flat valve, in others at the beak of the gibbous valve. Length and breadth of the shell. The length is measured from the cartilage or beak to the margin below, the breadth is of course taken in the opposite direction. The breadth of many bivalve shells exceeds their length: some remarkable instances of which occur in the solen tribe. Hinge, the point of union between the two valves, formed by the connection or articulation of the teeth in both valves, or by the teeth in one valve, fitting into hollows or sockets in the valve opposite. The amazing variety of structure observable in the hinge of different tribes of shells renders this one of the most essential characters in the generical definition of shells. The teeth in some are small and numerous, in others thick, solid, and few in number, or sometimes single, long, spatuliform, laminiform, acicular, &c. the principal of which may be divided into inarticulate hinge, when only furnished with callosities, or having no visible teeth; articulate, when it has teeth, but only a small number; and multarticulate, when the teeth are numerous. Cicatrix, the impression on the inside of the valves indicating the point of connexion between the muscles of the animal, and its shell. In some kinds, as the common oyster for example, there is only one such muscular impression in each valve, in others there are two, and some have more. The cicatrix is not of the same figure in all shells, being either round, semi-ovate, lunate, or elongated, in different kinds. Byssus, the appendage called the beard; by means of which some bivalves fasten themselves to the rocks.

Multivalves. The shells of this order are few, compared with either of the preceding; and the terms proposed for those are applicable for the most part to the multivalves. The following require more explicit mention. Base, that part of the shell upon which it rests: in the lepas tribe, it implies the part immediately seated upon the stem or pedicle; in the balani the base is generally larger than the summit, and is the bottom by means of which the shell is fixed upon the rocks or other extraneous bodies. Ligament, the substance, whether membranaceous or tendinous, which serves to connect the valves together. The connexion of the valves in some multivalves is formed by the parts of one valve locking into another. Operculum. The balani have the aperture at the summit closed by means of four small pieces or valves, which are commonly called the operculum; these opercula of the balani are, however, very different from those of univalve shells.

The primary divisions of the Linnæan system, in the latest edition of the "Systema Naturæ," as before observed, consist of three orders, Multivalve, Bivalve, and Univalve, each of which is subdivided into genera. The Multivalves contain the chiton, lepas and pholas; the Bivalves, mya, solen, tellina, cardium, mactra, donax, venus, spondylus, chama, arca, ostrea, anomia, mytilus, and pinna; and the Univalves, argonauta, nautilus, conus, cypræa, bulla, voluta, buccinum, strombus, murex, trochus, turbo, helix, nerita, haliotis, patella, dentalium, serpula, teredo, and sabella. Which see. See also SHELLS.

CONCLAVE, the place in which the cardinals of the Romish church meet, and are shut up, in order to the election of a pope. The conclave is a range of small cells, ten feet square, made of wainscot: these are numbered, and drawn for by lot. They stand in a line along the galleries and hall of the Vatican, with a small space between each. Every cell has the arms of the cardinal over it. The conclave is not fixed to any one determinate place, for the constitutions of the church allow the cardinals to make choice of such a place for the conclave as they think most convenient; yet it is generally held in the Vatican. The conclave is very strictly guarded by troops: neither the cardinals, nor any person shut up in the conclave, are spoke to but at the hours allowed of, and then in Italian or Latin; even the provisions for the conclave are examined, that no letters be conveyed by that means from the ministers of foreign powers, or other persons who may have an interest in the election of the pontiff.

CONCLUSION, in logic, the conse-

quence or judgment drawn from what was asserted in the premises; or the previous judgments in reasoning, gained from combining the extreme ideas between themselves.

CONCORD, in grammar, that part of construction, or syntax, in which the words of a sentence agree; that is, in which nouns are put in the same gender, number, and case; and verbs in the same number and person with nouns and pronouns.

CONCORD, in music, the relation of two sounds that are always agreeable to the ear, whether applied in succession or consonance. See MUSIC.

CONCORDANCE, a sort of dictionary of the Bible, explaining the words thereof in alphabetical order, with the several books, chapters, and verses quoted, in which they are contained.

CONCORDAT, a covenant or agreement with the Pope concerning the acquisition, permutation, and resignation of ecclesiastical benefices. In France the term concordat denoted formerly an agreement concluded at Bologna, in 1516, between Pope Leo X. and Francis I. of France, for regulating the manner of nominating to benefices; but at present it applies exclusively to a convention exchanged between Pope Pius VII. and the French government on the 10th of September, 1801, in which the Roman Catholic religion is acknowledged to be that of the majority of the French people, and the free exercise of their religion is conceded to Calvinists and Lutherans under the superintendance of government.

CONCRETE, in logic, is used in contradistinction to abstract; for example, when we consider any quality, as whiteness, inhering in any subject, as suppose in snow: if we may say the snow is white, then we speak of whiteness in the concrete; but if we consider whiteness by itself, as a quality that may be in paper, in ivory, and in other things, as well as in snow, we are then said to consider, or to take it in the abstract.

CONCRETIONS, *morbid*, in animal economy, hard substances that occasionly make their appearance in different parts of the body, as well in the solids as in those cavities destined to contain fluids: in the first place they are denominated concretions, or ossifications: in the other calculi. The concretions that make their appearance in the solids of the animal body are denominated pineal concretions, from their being found in that part of the brain called the pineal gland; or salivary concretions, as being discovered occasionally in the salivary glands; or pancreatic concretions, which are hard substances found in the pancreas; or pulmonary concretions, which have been sometimes coughed up by consumptive persons; or hepatic concretions, of which the liver is sometimes full: concretions have also been found in the prostate; these have all been examined by chemists, and found to consist of phosphate of lime and other substances. Concretions have been discovered in the intestines and stomach of the human body, but more frequently in those of animals: those found in the intestines of a horse were examined by Fourcroy, and found to consist of magnesia, phosphoric acid, ammonia, water, and animal matter. See CALCULI and CHALK STONES.

CONDENSER, a pneumatic engine or syringe, whereby an uncommon quantity of air may be crowded into a given space; so that sometimes ten atmospheres, or ten times as much air as there is at the same time in the same space, without the engine, may be thrown in by means of it, and its egress prevented by valves properly disposed. See PNEUMATICS.

CONDIMENTS. Although these are not properly alimentary matters, or such as become ingredients in the composition of the animal fluid; yet Dr. Cullen says, they are taken with advantage along with the proper aliments, the digestion and assimilation of which they in some degree modify. They are of two kinds, saline or acrid; having this acrimony for the most part residing in their oily parts. Of the first, the chief is sea-salt, and it is especially employed for preserving meat, before it is employed in diet, for a longer time than it could be otherwise preserved from putrefaction. For this purpose salt is applied in large proportions, and so incorporated with the substance of the meat, that it cannot be again washed out before the meat is employed in diet. Hence it happens, that when salted meats are eaten in that condition, the salt is often taken in, in large quantity, and diffused in the mass of blood. If the salted meats, however, be taken in moderate quantity only, Dr. Cullen says, the salt has the effect of exciting the powers of digestion; and such meat is often more easily digested than entirely unsalted meats are.

Another important condiment is sugar. It is certainly antiseptic, and therefore properly employed in preventing the putrefac-

tion of meat. It is also frequently applied to vegetables; but from the preparation of boiling, which is commonly necessary in order to their being impregnated with the sugar, the condita, except a few that contain a large proportion of a more fixed aromatic substance, can be considered only as sugar. This is often applied to the acid and acescent fruits; and when applied in the consistence of a syrup, it preserves them for a long time from any fermentation, but it does not destroy their ascescency; and when such preserves are taken into the stomach, the sugar introduced along with them renders them much disposed to an acescent fermentation. In the quantity that sugar is commonly employed, either for improving the relish of several kinds of food, or for correcting their acidity, it can only be hurtful by its ascescency in the stomach, and can hardly make any proper part of the mass of blood. If taken in very large quantities, and in greater proportion than it can enter into the composition of the animal fluid, sugar, Dr. Cullen thinks, may increase the saline state of the blood, and induce disorders.

Vinegar, another saline condiment, is a powerful antiseptic, employed in several ways for preserving animal substances from putrefaction. We must consider vinegar as a vegetable acid that may be taken with more safety than the fossil acids. Acrid substances are also employed as condiments. These are especially taken from the class of tetradynamia, and they are chiefly the mustard and horse-radish. Taken in with our food, they stimulate the stomach and assist digestion; and further, as they evidently promote perspiration and urine, they obviate the putrescent tendency of the system. This has been so much remarked, that the vegetables of this class, as fraught with this peculiar acrimony, are justly denominated antiscorbutic.

To the list of condiments, Dr. Cullen adds capsicum, ketchup, and soy; and concludes his strictures on them by observing, that the whole of our seasonings consist of salt, vinegar, and aromatics, combined together: and "if they are taken only in the quantity necessary to render the food more sapid, they may increase the appetite and favour full eating; but they can hardly otherwise do harm, unless when the aromatics are taken in such large quantity as to weaken the tone of the stomach."

CONDITION, in law, a restraint annexed to a thing, one of the terms upon which a grant may be made on a contingency, upon the happening of which, the estate may be defeated; as a mortgage which is to cease upon payment of a certain sum. Conditions are either in deed, or express; in law, or implied; precedent; subsequent; inherent; collateral; affirmative; negative; single; copulative. A condition precedent is one the happening of which is to precede the vesting of the estate or thing granted. A condition subsequent, by happening after the vesting of the estate defeats, continues or extends it; and this distinction is of frequent occurrence and great importance. A condition in deed differs from a limitation of an estate, chiefly in that the former defines the estate, which cannot exceed the limits set to it in the original grant; but upon an express condition in deed, the estate continues until the grantor, who may take advantage of it, enters to defeat it. See LIMITATION. Conditions which are impossible, contrary to law, or repugnant to the nature of the estate, are void, and consequently the estate, if the condition be subsequent, becomes absolute by being freed from the condition; but, if precedent, the estate can never vest. Those which give or enlarge an estate are favourably, those which restrain or defeat it, strictly construed, and conditions in restraint of marriage are not favoured, unless reasonable, but must be performed where the thing is limited over to a third person. The right of taking advantage of a condition can be reserved only to the party, his heir, executor, or privities, in right and representation. A familiar instance of a condition is a bond with a penalty, conditioned to be void on payment of a less sum.

CONDITION, or *Condition implied*, is when a person grants an office to another, as keeper of a park for life; though there be no condition expressed in the grant, yet the law makes one covertly, which is, that if the grantee does not execute all things belonging to his office, it shall be lawful for the grantor to discharge him.

CONDITIONAL *syllogism*, a syllogism where the major is a conditional proposition. Thus,

If there is a God, he ought to be worshipped.
But there is a God;
Therefore he ought to be worshipped.

CONDUCTOR, in surgery, an instrument which serves to conduct the knife in

the operation of cutting for the stone, and in laying open sinuses and fistulas.

Conductors, in electricity, are long metal rods, whose points are raised so high as may be convenient, above houses, &c. for the purpose of attracting or receiving the electric fluid, and of conducting it into the earth, or into water, thereby to prevent the building from being struck by lightning. To effect this, the rod should be detached, and its point should be sharp; by which mean the electric fluid will be silently discharged. If the conductor is allowed to lay along the wall of the house, or that it is blunt, instead of being pointed, at its summit, it will attract the lightning, which in such case will do more or less damage to the building. Thus the rod should be kept from the walls, &c. by pieces of well-seasoned wood, coated with resin, or of lead, which as well as glass, sealing-wax, sulphur, bees'-wax, oil-water, &c. are all non-conductors while cold; though, when heated to a great degree, they become conductors. The rod should pass freely from the top of the building to the ground, without the line of its continuity being any where broken. It is found that black lead is an excellent aid, both to affix as a sharp point to the apex, and to be laid at a few feet deep in the earth where it is moist, and surrounded by a bed of charcoal. The rod should pass into the mass of black lead, which will cause the electric fluid to be extinguished. Where buildings are extensive, and especially where there are many high chimneys, turrets, &c. two or more conductors should be used; else the electric fluid, in its passage from a charged cloud, may be intercepted by such heights, and do considerable injury. Trees standing single on plains are very dangerous conductors, as are those lofty trees that rear their heads conspicuously in large woods. Hence we so often see them rent to pieces by lightning, and such cattle as take refuge under their inviting shelter destroyed. Walls are conductors when lightning has entered a room; therefore all persons should avoid sitting near them during thunder storms; and in countries where lightning is frequent, care should be taken to remove iron bars, &c. For the various amusing and interesting matters relating to Electricity, we must refer the reader to that article and to Galvanism.

CONDYLOMA, in medicine, a tubercle or callous eminence which arises in the folds of the anus, or rather a swelling or hardening of the wrinkles of that part.

CONE, in geometry, a solid figure, having a circle for its base, and its top terminated in a point or vertex.

Cone, *Properties of the.* 1. Cones and pyramids having the same bases and altitudes are equal to each other. It is shewn, that every triangular prism may be divided into three equal pyramids, and therefore that a triangular pyramid is one third of a prism standing on the same base, and having the same altitude. Hence, since every multangular body may be resolved into triangular ones, every pyramid is the third part of a prism standing upon the same base, and having the same altitude; and as a cone may be esteemed an infinite angular pyramid, and a cylinder an infinite angular prism, a cone is the third part of a cylinder which has the same base and altitude. Hence we have a method of measuring the solidity and surface of a cone and pyramid. Thus, find the solidity of a prism or cylinder, having the same base with the cone or pyramid, which found, divide by three, the quotient will be the solidity of the cone or pyramid. Or the solidity of any cone is equal to the area of the base, multiplied into one third part of its altitude. As for the surfaces, that of a right cone, not taking in the base, is equal to a triangle whose base is the periphery and altitude the side of the cone; therefore the surface of a right cone is had by multiplying the periphery of the base into half of the side, and adding the product to that of the base.

2. The altitudes of similar cones are as the radii of the bases, and the axes likewise are as the radii of the bases, and form the same angle with them.

3. Cones are to one another in a ratio compounded of their bases and altitudes.

4. Similar cones are in a triplicate ratio of their homologous sides, and likewise of their altitudes.

5. Of the cones standing upon the same base, and having the same altitude, the superficies of that which is most oblique is the greatest, and so the superficies of the right cone is the least; but the proportion of the superficies of an oblique cone to that of a right one, or which is the same thing, the comparison thereof to a circle, or the conic sections, has not yet been determined.

Cones of the higher kinds, those whose bases and sections parallel to the bases, are circles of the higher kinds. They are gene-

rated by supposing a right line fixed in a point, on high, but conceived to be capable of being extended more or less on occasion, and moved round the periphery of a circle.

CONFECTION. See PHARMACY.

CONFEDERACY, is when two or more confederate, to do any damage or injury to another, or to commit any unlawful act. And though a writ of confederacy do not lie if the party be not indicted, and in a lawful manner acquitted, yet false confederacy between divers persons shall be punished, though nothing be put in execution.

CONFERVA, in botany, river weed, a genus of the Cryptogamia Algæ. Essential character: unequal tubercles, in very long capillary filaments. Twenty-one species are recited in Linnæus's system of vegetables. These are all inhabitants of the water, some in fresh, but more in salt water. A singular instance of irratibility has been observed in the Conferva corallina, upon its being immersed into fresh water, after it has been in a few minutes, several fibres were observed to move in an horizontal direction with a quick convulsive twitch, and then to stop suddenly: this they continued to do for some length of time, and the same effect may be produced several times, provided the plant be fresh. The experiment does not succeed in salt water.

CONFESSION of an offence, is when a prisoner is arraigned, and his indictment being read, either he confesses the offence, or pleads not guilty. Confession is express or implicit. Express, is where one in open court confesses the crime, is the most satisfactory ground of conviction. Implied, is where the defendant, in a case not capital, yields to the king's mercy, and desires to submit to a small fine; which the court may accept without requiring a direct confession. The presumption of guilt in this case is so strong, that the defendant cannot afterwards in a civil action deny the trespass.

Confession, previous to trial, before a justice, &c. may also be given in evidence afterwards, as against the individual confessing; but it must be voluntary, not upon promise or threats, and must be taken in time. After confession the party may take advantage of errors in the indictment in arrest of judgment. Confession may also be in a civil action, and is commonly on a warrant of attorney for that purpose, which being after accompanied with a bond is vulgarly called a bond and judgment.

CONFIRMATION, is a conveyance of an actual, not a reversionary estate or right, which one has to lands, &c. to another having the possession of or in being, an estate in them whereby that estate is increased, the possession made perfect, or if voidable, it is rendered secure. It does not regularly create an estate, but may be connected with words which create a further estate. It is necessary that the one party should have an estate in possession by right or wrong, and the other an estate on right from which the confirmation may come, and the one estate must continue till the other operates.

CONFIRMATION, in rhetoric, the third part of an oration, wherein the orator undertakes to prove the truth of the proposition advanced in his narration; and is either direct or indirect. Direct, confirms what he has to urge for strengthening his own cause. Indirect, properly called confutation, tends to refute the arguments of his adversaries.

CONFISCATE, from *confiscase*, and that from *fiscus*, the emperor's treasure. Any goods which being disclaimed by another, as a felon upon trial, comes to the king, although they are the felon's own. Those which he claims, as his own, are, upon conviction, not confiscate, but forfeited to the king.

CONFUSION *of tongues*, a memorable event which happened, according to the Hebrew chronology, one hundred and one years after the flood, at the overthrow of Babel, and which was providentially brought about to facilitate the dispersion of mankind, and the population of the earth. Hitherto there had been but one common language, which formed a bond of union, that prevented the separation of mankind into distinct nations, and some have imagined that the tower of Babel was erected as a kind of fortress, by which the people intended to defend themselves against that separation, which Noah had projected.

CONGE D'ESLIRE. The king's permission royal to a dean and chapter, in time of vacation of the see, to choose or elect a bishop. See BISHOP.

CONGELATION, may be defined the transition of a liquid into a solid state, in consequence of an abstraction of heat: thus metals, oil, water, &c. are said to congeal when they pass from a fluid into a solid state. With regard to fluids, congelation and freezing meaning the same thing. Water congeals at 32°, and there are few liquids that will not congeal, if the temperature be brought sufficiently low. The only difficulty is to obtain a temperature

equal to the effect; hence it has been inferred that fluidity is the consequence of caloric. See FLUIDITY. Every particular kind of substance requires a different degree of temperature for its congelation, which affords an obvious reason why particular substances remain always fluid, while others remain always solid, in the common temperature of the atmosphere, and why others are sometimes fluid, and at others solid, according to the vicissitudes of the seasons, and the variety of climates. See COLD, FREEZING.

CONGREGATION, an assembly of several ecclesiastics united, so as to constitute one body; as an assembly of cardinals, in the constitution of the pope's court, met for the dispatch of some particular business.

CONGREGATION is likewise used for assemblies of pious persons, in manner of fraternities.

CONGREGATIONALISTS, in church history, a sect of protestants who reject all church government, except that of a single congregation. In other matters, they agree with the presbyterians. See PRESBYTERIANS.

CONGRESS, in political affairs, an assembly of commissioners, envoys, deputies, &c. from several courts meeting to concert matters for their common good.

CONGRUITY, in geometry, is applied to figures, lines, &c. which being laid upon each other, exactly agree in all their parts, as having the very same dimensions.

CONIC *sections*, as the name imports, are such curve-lines as are produced by the mutual intersection of a plane and the surface of a solid cone. The nature and properties of these figures were the subject of an extensive branch of the ancient geometry, and formed a speculation well suited to the subtle genius of the Greeks. In modern times the conic geometry is intimately connected with every part of the higher mathematics and natural philosophy. A knowledge of those discoveries that do the greatest honour to the last and the present centuries, cannot be attained without a familiar acquaintance with the figures that are now to engage our attention.

We are chiefly indebted to the preservation of the writings of Apollonius for a knowledge of the theory of the ancient geometricians concerning the conic sections. Apollonius was born at Perga, a town of Pamphylia, and he is said to have lived under Ptolemy Philopater, about forty years posterior to Archimedes. Besides his great work on the conic sections, he published many smaller treatises, relating chiefly to the geometrical analysis, which have all perished. The treatise of Apollonius on the conic sections is written in eight books, and it was esteemed a work of so much merit by his contemporaries as to procure for its author the title of the great geometrician. Only the four first books have come down to us in the original Greek. On the revival of learning the lovers of the mathematics had long to regret the original of the four last books. In the year 1658, Borelli, passing through Florence, found an Arabic manuscript in the library of the Medici family, which he judged to be a translation of all the eight books of the conics of Apollonius: but, on examination, it was found to contain the first seven books only. Two other Arabic translations of the conics of Apollonius have been discovered by the industry of learned men: and as they all agree in the want of the eighth book, we may now regard that part of the treatise as irrecoverably lost. The work of Apollonius contains a very extensive, if not a complete, theory of the conic sections. The best edition of it, is that published by Dr. Halley in 1710: to which the learned author has added a restoration of the eighth book, executed with so much ability as to leave little room to regret the original.

Since the revival of learning the theory of the conic sections has been much cultivated, and is the subject of a great variety of ingenious writings. Dr. Wallis, in his treatise "De Sectionibus Conicis," published at Oxford in 1655, deduced the properties of the curves from a description of them on a plane. Since this time authors have been much divided as to the best way of defining the curves, and demonstrating their elementary properties; many, in imitation of the ancient geometricians, making the cone the groundwork of their theories; while others have followed the example of Dr. Wallis.

OF THE CONE AND ITS SECTIONS.

Definitions.

Let A D B be a circle (Fig. 1. Plate I. Conic Sections) and V a fixed point without the plane of the circle; then, if a right line, passing continually through the point V, be carried round the whole periphery of the circle A D B, that right line, being extended indefinitely on the same side of V as the circle, will describe a conic surface; and, if it be likewise extended indefinitely on the other side of V it will describe two opposite conic surfaces.

Cor. A straight line drawn from the vertex to any point in a conic surface, being produced indefinitely, is wholly in the opposite surfaces.

For a line, so drawn, will coincide with the line that generates the conic surfaces, when this line, by being carried round the circumference of the base, comes to the proposed point.

II. The solid figure, contained by the conic surface and the circle A D B, is called a cone. The point V is named the vertex of the cone; the line V C, drawn to the centre of the circle, the axis of the cone; and the circle A D B, the base of the cone.

III. A right cone is when the axis is perpendicular to the plane of the base; otherwise it is a scalene, or oblique cone.

IV. A right line that meets a conic surface in one point only, and is every where else without that surface, is called a tangent.

PROP. I.

Fig. 1. The common intersection of a conic surface and a plane V D E, that passes through the vertex, and cuts the base of the cone, is a rectilineal triangle.

For the common section of the plane of the base, and the plane drawn through the vertex (which is a right line 3. 11. E) will cut the periphery of the base in two points, D and E, and in these two points only: then, having drawn D V and E V to the vertex of the cone, these lines will be both in the conic surface (Cor. Def. 1.), and also in the plane surface; and there are no points, excepting in these lines indefinitely produced, which are common to both the surfaces. Therefore the figure D V E, which is the common intersection of the cone and a plane through the vertex, is a rectilineal triangle.

PROP. II.

Fig. 2. If a point, E, be assumed in a conic surface, and a line, P Q, be drawn through it so as to be parallel to a right line, V B, passing through the vertex, and contained in the conic surfaces; then the right line P Q, will not meet either of the opposite surfaces in another point, but it will fall within the surface in which the assumed point E is, on the one side, and it will be wholly without both surfaces on the other side.

For if a plane be conceived to be drawn through the line V B and the point E, the line P Q, parallel to V B, will be wholly in that plane, 7. 11. E; and the common sections of the plane and the conic surfaces will be the line V B and the line V E C drawn through the vertex and the point E, Pr. 1. Now the line, Q P, does not meet either of the lines V B or V C in another point different from E. Also Q E, the part of the line that is contained in the angle B V C, is within the cone; and P E, the part of it that is contained in the angle C V N, is without both the opposite surfaces.

PROP. III.

Fig. 3. If a plane be drawn through the vertex of a cone and a tangent of the conic surface G H, it will meet the conic surface only in the line V D, drawn through the vertex of the cone and the point of contact of the tangent.

For, because the point D and the vertex V are common both to the plane surface and to the conic surface, therefore the line V D, indefinitely produced, is likewise common to both surfaces. And because G H meets the conic surface only in the point D, and is every where else without the surface, therefore any line (different from V D) as V F, drawn in one of the conic surfaces, is contained on one side of the plane; and the same line continued in the opposite conic surface, as V K, is contained on the other side of the plane.

Cor. 1. Any straight line drawn in the plane, V G H, so as to meet the line V D, is a tangent of the conic surfaces.

Cor. 2. No other plane, besides the plane V G H, can be drawn so as to touch the conic surfaces in the line V D without cutting them.

For, R S the common section of the plane V G H, and the plane of the base is a tangent to the periphery of the base, Cor. 1. And, if there were two such planes, there would likewise be two tangents of a circle drawn through the same point of the periphery, which is absurd.

PROP. IV.

Fig. 4. A right line drawn through a point of a conic surface, so as neither to be a tangent, nor to be parallel to a right line contained in the conic surface, will meet either the same, or the opposite, conic surface again in another point.

Let a plane be drawn through the vertex of the cone and the right line (D B or D C), then that plane will cut the cone; for if it did not the right line (D B or D C) would

be a tangent contrary to the hypothesis. Let V G and V H be the common sections of the plane and the conic surface; then the right line (D B or D C) will not be parallel to V H contained in the conic surface (h y p), therefore it will meet V H either in the same conic surface (as D B), or, when produced in the opposite conic surface (as D C).

PROP. V.

Fig. 5. If either of two opposite conic surfaces be cut by a plane parallel to the base of the cone, the section is a circle, having its centre in the axis of the cone.

Through V C, the axis of the cone, let two planes be drawn cutting the base in the lines C D and C E, and the plane parallel to the base in the lines G H and G L, and the conic surfaces in the lines V H D and V L E: then, because the base is parallel to the cutting plane, therefore C D is parallel to G H, and C E to G L, 16. 11. E. Therefore, on account of equiangular triangles. 4. 6. E.

$$DC : CV :: HG : GV$$
$$CV : CE :: GV : GL$$
$$\text{Ex æquo } DC : CE :: HG : GL$$

But $DC = CE$, therefore $HG = GL$. And in like manner it may be shewn that any right line drawn from G to a point in the intersection of the plane, and the conic surface is equal to G H; therefore the section is a circle.

Cor. If, through a point situated within or without a conic surface, two straight lines, both parallel to the plane of the base of the cone (that is, parallel to straight lines in that plane), be drawn to cut or touch the conic surface: then the rectangle contained by the two segments (between the point and the conic surface), of one of the lines when it cuts, or the square of its segment when it touches the conic surface, is equal to the rectangle contained by the two segments of the other line when it cuts, or to the square of its segment when it touches the conic surface.

For a plane drawn through the two lines will be parallel to the plane of the base, 15. 16. E; and it will intersect the conic surface in the periphery of a circle: whence the corollary is manifest, 35 and 36. 3. E.

When a straight line drawn through a point, situated within or without a cone, meets one or both of the conic surfaces in two points, it is called a secant; and the two parts of such a line, between the point through which it is drawn, and the conic surface or surfaces, are called the segments of the secant. And when a line, drawn from a point without a cone, touches one of the conic surfaces; that part of it between the point from which it is drawn and the conic surface is denoted by the word tangent in the following propositions.

PROP. VI.

Fig. 6, 7, and 8. If a straight line be drawn from the vertex of a cone to a point, as B, in the plane of the base, but not in the periphery of the base; and, through any point, as P, situated without or within the cone, another straight line, parallel to the former, be drawn to cut or touch the conic surface or opposite surfaces; then the square of the line drawn from the vertex of the cone to the point B is to the rectangle under the segments of the secant, or to the square of the tangent, drawn from the point P, as the rectangle under the segments of any line drawn from B to cut the base of the cone, is to the rectangle under the segments of any line, parallel to the base of the cone, drawn through the point P, to cut the conic surface.

Fig. 6. Let the point B be without the base of the cone, and let Q R, drawn through P without or within the conic surface, be parallel to V B, and let it cut the conic surface in Q and R: through P and the line V B draw a plane cutting the conic surface in the lines V G and V H, and the plane of the base in the line B G H; and through P draw L K parallel to G H. Because V B and P R Q are parallel, therefore the line P R Q is contained in the plane B V P, 7. 11. E; and the points Q and R are in the lines V H and V G, the common sections of the plane and the conic surface. Because Q P is parallel to V B, and L K to G H, therefore the triangle Q P L is equiangular to the triangle V B H, and the triangle P K R to the triangle V G B: therefore 4. 6. E.

$$VB : PR :: BG : PK$$
$$VB : PQ :: BH : PL$$

Consequently, $VB^2 : PR \times PQ :: BG \times BH : PK \times PL$, 23. 6. E. But the rectangle $BG \times BH$ is equal to the rectangle under the segments of any other line drawn from B to cut the base of the cone, 35 and 36 . 3. E; and the rectangle $PK \times KL$ is equal to the rectangle under the segments of any other line, parallel to the plane of the base, drawn from P to cut the conic surface, Cor. Pr. 5; and hence the proportion is manifest in this case.

Fig. 7. And if the point B be within the

Fig. 1.

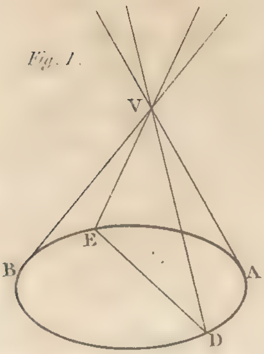


Fig. 2.

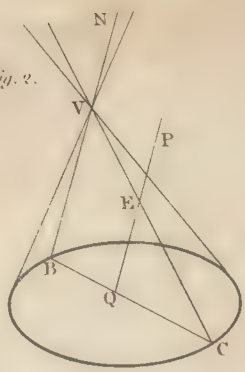


Fig. 3.

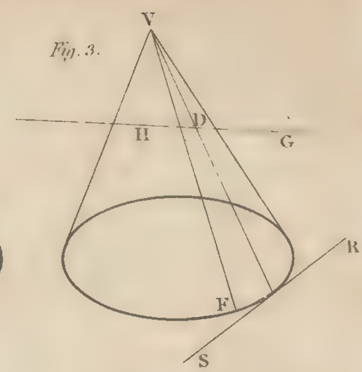


Fig. 4.

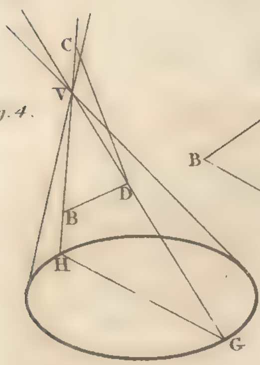


Fig. 6.

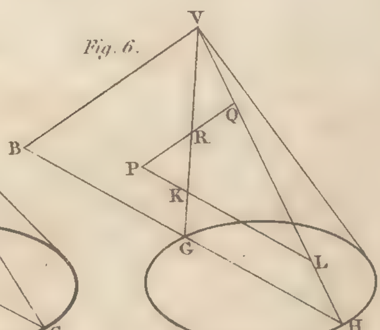


Fig. 5.

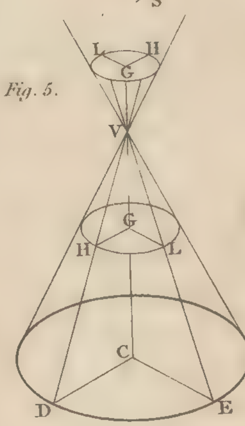


Fig. 7.

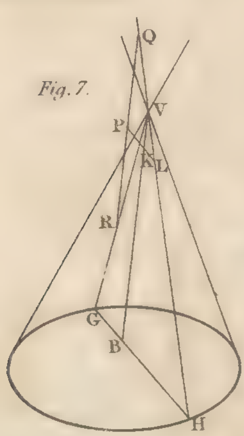


Fig. 8.

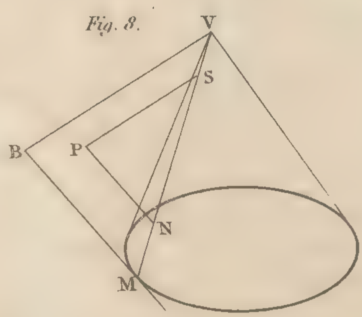


Fig. 9.

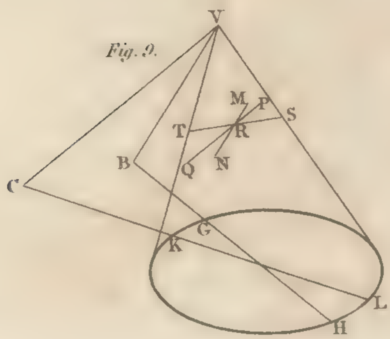
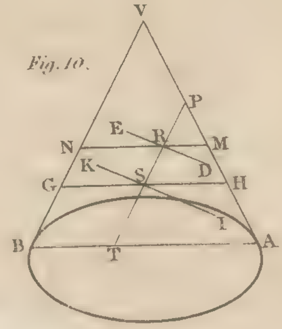


Fig. 10.



Lowry sculp.

London. Published by Longman Hurst, Rees & Orme June 1808.

base of the cone, and a straight line (as PQR), parallel to the line VB that joins the point B and the vertex of the cone, be drawn to cut the opposite surfaces through a point P, situated without or within the cone: the proposition may be demonstrated in this case, in the very same words as in the former case.

And if the point P (fig. 8.) be without the cone as well as the line VB, and PS, parallel to VB, be drawn to touch the conic surface, instead of cutting it; then the plane PVB will meet the conic surface in a line VSM; and BM will touch the base of the cone, and PN, parallel to BM, will touch the conic surface. And because the two triangles SPN and VBM are equiangular, therefore

$$VB : PS :: BM : PN$$

$$\text{And } VB^2 : PS^2 :: BM^2 : PN^2$$

But BM^2 is equal to the rectangle under the segments of any line drawn from B to cut the base of the cone; and PN^2 is equal to the rectangle under the segments of any line, parallel to the base of the cone, drawn from P to cut the conic surface; and hence the proposition is manifest in this case also.

PROP. VII.

Fig. 9. If a point be assumed without or within a cone, and two lines be drawn through it to meet a conic surface, or opposite surfaces, and so as to be parallel to two straight lines given by position; then the rectangle under the segments of the secant, or the square of the tangent, parallel to one of the lines given by position, has to the rectangle under the segments of the secant, or to the square of the tangent, parallel to the other line given by position, a ratio that is constantly the same, wherever the point (from which the lines are drawn) is assumed without or within the cone.

Let VB and VC be two straight lines, (fig. 9.) drawn from the vertex of a cone to the plane of the base, and given by position (or parallel to lines given by position); and let PQ and MN be two straight lines drawn through any assumed point, as R, to cut the conic surface, and so as to be respectively parallel to CV and VB: and as CV^2 is to the rectangle $CK \times CL$ (contained by the segments of any line drawn from C to cut the base of the cone), so let D, any assumed line, or magnitude, be to E; and as VB^2 is to $BG \times BH$ (the rectangle contained by the segments of any line drawn from B to cut the base of the cone), so let F be to E; and draw ST parallel to the base of the cone through the point R; then, Pr. 6.

($CV^2 : CK \times CL$, or) $D : E :: PR \times RQ : SR \times RT$, and $BV^2 : BG \times BH$, or) $F : E :: MR \times RN : SR \times RT$. Therefore invertendo and ex æquo,

$$D : F :: PR \times RQ : MR \times RN.$$

And, as the same reasoning applies wherever the point R is assumed, therefore the ratio of the rectangles $PR \times RQ$, and $MR \times RN$ is the same with, or equal to, the constant ratio of D to F, wherever the point R is assumed.

And, in like manner, may the proposition be demonstrated in all other cases, or in all positions of the lines PQ, and MN, whether they cut, or touch, the same or opposite surfaces.

PROP. VIII.

Fig. 10. If a right line, as PT, drawn through a point P in the surface of a cone, so as to be parallel to a right line VB contained in the conic surface, meet two parallel lines (in the points R and S) that cut or touch the conic surface or opposite surfaces: then PR is to PS as the rectangle under the segments of the secant, or the square of the tangent, drawn through the point R, is to the rectangle under the segments of the secant, or to the square of the tangent, drawn through the point S.

Through the two parallels PT and VB (fig. 10.) draw a plane cutting the conic surface again in the line VA, and the plane of the base in the line BA; and, through R and S, draw MN and HG parallel to AB. Because PT is parallel to VB, and RN to SG, therefore RNGS is a parallelogram; and RN is = GS. It is obvious that the triangles PMR and PHS are equiangular: therefore PR is to PS as MR is to HS, 4. 6. E, or as $MR \times RN$ is to $HS \times SG$, 1. 6. E. But $MR \times RN$ and $HS \times SG$ are respectively equal to the rectangles contained by the segments of any two lines, parallel to the base of the cone, drawn through R and S to cut the conic surface, Cor. Pr. 5, and hence the proposition is manifest, when PT meets two lines parallel to the plane of the base.

And if PT meet two parallel lines DE and IK, not parallel to the plane of the base; then, let the same construction be made as before: and because DE is parallel to IK, and MN to GH; therefore,

$$DR \times RE : MR \times RN :: IS \times SK : HS \times SG;$$

Alternando, $DR \times RE : IS \times SK :: MR \times RN : HS \times SG$. Therefore, as is obvious from what has already been shewn,

$$PR : PS :: DR \times RE : IS \times SK.$$

And if S be without the cone, and the line drawn through it touch the conic surface instead of cutting it, the reasoning is still the same when the square of the tangent is taken in place of the rectangle under the segments of the secant.

PROP. IX.

Fig. 11. Let a scalene cone be cut by a plane drawn through the axis perpendicular to the plane of the base, making the triangular section V A B; and let V D, cutting A B produced in D, be drawn so as to make the angle B V D equal to the angle V A B, and draw M N in the plane of the base, perpendicular to A D; then every section of the cone, as P S Q, made by a plane parallel to the plane V M N (called a subcontrary section) is a circle; and every circular section of the cone, which is not parallel to the base, is a subcontrary section.

Draw T S in the plane of the section parallel to M N, which is plainly possible, because the two planes P Q and V M N are parallel: because T S is parallel to M N, a line in the plane of the base, therefore every plane drawn through S T will cut the base in a line parallel to S T (16. 11. E.): therefore L O K, the common section of the base, and a plane drawn through V and S T is parallel to S T and M N (9. 11. E.): therefore K O L is perpendicular to A B, and it is bisected in O: therefore S T is bisected in R. Again, the line P Q is parallel to V D, therefore $VD^2 : PR \times RQ :: AD \times DB : TR \times RS$ (6.) But if a circle be described about the triangle A V B, D V will be a tangent of that circle (32. 3. E.): therefore $VD^2 = AD \times DB$, and consequently, $PR \times RQ = TR \times RS$, or RT^2 (36. 3. E.). Because the plane A V D is perpendicular to the base (*h y p*), and M N is perpendicular to A D: therefore M N is perpendicular to the plane A V D: therefore T R, parallel to M N, is perpendicular to the same plane, and to P Q. And, hence, from what has already been shewn, the section P Q is a circle.

Next let P Q be a circular section, not parallel to the base of the cone: draw a plane through the vertex, parallel to the plane P Q, and let it cut the base in the line M N: draw A D through the centre of the base perpendicular to M N, and let a plane drawn through V and A D cut the parallel planes in the lines P Q and V D, and the conic surface in the lines A V and V B: draw the plane V T L K S through S T parallel to M N, as before. It is shewn, as above, that T S is bisected in R: and, in like manner, it may be proved that any other line, as G H, parallel to M N is bisected. Because P Q, a line in a circle, bisects two or more parallels, it is a diameter of the circle, and it cuts all the parallels at right angles. Because T S is perpendicular to P Q, therefore M N is perpendicular to D V (parallel to P Q): but M N is also perpendicular to D A: therefore it is perpendicular to the plane D A V (4. 11. E.): therefore A V B is a section of the cone through the axis at right angles to the base (18. 11. E.). Again, because the section is a circle, therefore $PR \times RQ = SR \times RT$: consequently $VD^2 = AD \times DB$ (Pr. 6.): Therefore V D is a tangent of the circle described about the triangle A V B, and the angle D V B is equal to the angle A V B (32. 3. E.). Therefore the circular section is a subcontrary one.

Cor. No other than a parallel and a subcontrary section of a cone is a circle.

Fig. 12, 13, 14. If a cone be cut by a plane P Q which neither passes through the vertex, nor is parallel to the base, then a plane, as V M N being drawn through the vertex parallel to the cutting plane, it will necessarily meet the plane of the base of the cone. The line of common section of the parallel plane, and the base of the cone M N, may have one or other of these three different positions, *viz.*

1. It may be without the base of the cone.

2. It may touch the periphery of the base.

3. It may cut the periphery of the base.

These three different cases offer three sections for our consideration, that are very different from one another, and possess many properties peculiar to each, while they have many common to all the three.

Def. 5. *Fig.* 12. If the line of common section M N be without the base of the cone, then the plane V M N drawn through the vertex will be entirely between the two conic surfaces, not meeting either of them. In this case the cutting plane P Q will meet every line drawn in one of the conic surfaces, and the curve line of common section will surround that conic sur-

face, and will completely inclose a space. In this position of the cutting plane, the line of common section, unless when it is a circle, is called an ellipse.

Def. 6. *Fig.* 13. If the line of common section M N, touch the periphery of the base of the cone, then the plane drawn through the vertex will touch the conic surfaces (Pr. 3), and the opposite surfaces will be on opposite sides of it. In this case the cutting plane will meet every line drawn from the vertex in one of the conic surfaces, excepting only the line V B, in which the touching plane meets the conic surface; and as the cutting plane is indefinitely extended along the touching plane without meeting it, it is obvious that the curve line, formed by the common section of the cutting plane and the conic surface, does not return into itself so as to inclose a space, but it is open on the side opposite to the vertex of the cone. In this position of the cutting plane, the conic section is called a parabola.

Cor. 1. Every right line, drawn in the plane of a parabola, which meets the curve in one point, but neither touches the curve, (see Def. 8), nor is parallel to the line V B in the conic surface, will meet the parabola again in another point. This is manifest from Prop. IV.

Cor. 2. All right lines drawn in the plane of a parabola, which meet the curve in one point only, but are not tangents, are parallel to one another. For they are all parallel to the line V B in the conic surface. (Cor. 1.)

Def. 7. *Fig.* 14. If the line of common section M N cut the periphery of the base, then the plane drawn through the vertex will divide each of the opposite conic surfaces into two parts lying on opposite sides of it. In this case the cutting plane being indefinitely extended, will meet every line drawn from the vertex in those parts of the two conic surfaces that lie on the same side of the plane through the vertex, as the cutting plane itself; and thus two curves will be formed by the common intersection of the cutting plane, and the two opposite conic surfaces. It is obvious that these curve lines may be indefinitely extended, and that they do not return into themselves so as to inclose a space. In this position of the cutting plane, the conic section formed by its intersection with one of the conic surfaces, is called a hyperbola; and the two conic sections formed by its intersection with the two opposite conic surfaces, are called opposite hyperbolas, or opposite sections.

Cor. 1. Let m V n be the common section of the cone, and a plane drawn through the vertex parallel to the plane of the two hyperbolas: then every right line drawn through a point of one of the hyperbolas, so as to be parallel to either of the two lines V m or V n, will not meet either of the two curves again in another point. (Pr. 2.)

Cor. 2. Every right line drawn in the plane of the hyperbolas, which meets one of the curves, but is not a tangent, nor parallel to V m nor V n, will meet the same, or the opposite hyperbola again in another point. (Pr. 4.) If it be parallel to V O, a line contained in the angle m V n, it will meet the opposite hyperbola: but if it be parallel to R V S, without the angle m V n, it will meet the same hyperbola again.

Def. 8. A right line drawn in the plane of a conic section, so as to meet the curve of the section in one point only, and which, being produced both ways, is contained on one and the same side of the section, is called a tangent of the section.

Cor. 1. A tangent of a conic section is a tangent of the conic surface. For it can meet the conic surface only in the point in which it meets the section.

Cor. 2. There cannot be more than one tangent of a conic section at the same point of the curve. For if there were two tangents, then two planes drawn through them and the vertex of the cone would meet the conic surface in the same right line without cutting the conic surface, which is absurd. (Cor. 2. Pr. 3.)

PROP. X.

If a point be assumed without, or within a conic section, and two straight lines be drawn through it to cut the section, or opposite sections, and so as to be parallel to two lines given by position: then the rectangle under the segments of the secant, or the square of the tangent, parallel to one of the lines given by position, will have to the rectangle under the segments of the secant, or to the square of the tangent, parallel to the other line given by position, a ratio that is always the same, wherever the point (through which the line is drawn) is assumed without or within the section. For secants and tangents of a conic section are secants and tangents of a conic surface: and thus this proposition is included in Proposition VII.

LEMMA. I.

Fig. 15. If there be any number of right lines, as D E, P Q, and F G, all parallel to one another, and all terminating in the same two right lines D F and E G; then a right line, as B C, which bisects two of the parallels will bisect all the rest.

Draw D H L and E K R parallel to B C: because $DB = BE$ and $FC = CG$, therefore $FL = RG$. It is plain that $FL : PH :: RG : KQ$; and therefore $PH = KQ$, consequently $PO = OQ$.

LEMMA. II.

Fig. 16. If a right line A B, or a right line produced, be so divided in C and D, that $AC \times CB = AD \times DB$: then $AC = BD$ and $AD = CB$.

Bisect A B in O. Then the difference of AO^2 and $AC \times CB$ is equal to CO^2 (5 and 6 . 2 . E); and the difference of AO^2 and $AD \times DB$ is equal to DO^2: therefore $CO^2 = DO^2$, whence the lemma is manifest.

PROP. XI.

Fig. 17, 18, 19, 20. If a right line, as B C, bisect two parallel right lines, D E and F G, terminated both ways by a conic section, or opposite sections: the same right line B C will bisect every other right line, as P Q, terminated by the section, or opposite sections, and parallel to the two former right lines.

Join D F and E G: then these lines are either parallel to one another, or, being produced, if necessary, they will meet.

I. When D F and E G are parallel: (fig. 17.) let P Q meet these lines in M and N: then $DM \times MF : PM \times MQ :: EN \times NG : PN \times NG$ (Pr. 10): but it is plain that $DM \times MF = EN \times NG$; therefore $PM \times MQ = PN \times NG$. Therefore $PM = NQ$ (Lem. 2.); and it is obvious that the right line B C, which bisects D E and F G, likewise bisects P Q (Lem. 1.)

II. Let F D and E G meet in a point H: (fig. 18, 19, 20.) assume any point, O, in the plane of the conic section, and through it draw T K, R S, and L I, terminated by the conic section, and respectively parallel to E G, D F, and D E or F G; let P Q meet D F and E G in M and N. It is manifest that D F and E G are similarly divided in M and N, and also in the point of concourse H. Therefore

$DM \times MF : EN \times NG :: FH \times HD : GH \times HE.$

Because T K is parallel to E G, and R S to D F: therefore

$FH \times HD : GH \times HE :: RO \times OS : TO \times OK.$

Consequently $DM \times MF : EN \times NG :: RO \times OS : TO \times OK$. Hence, and by Prop. 10, we have the following proportions:

$PM \times MQ : DM \times MF :: LO \times OI : RO \times OS.$

$DM \times MF : EN \times NG :: RO \times OS : TO \times OK.$

$EN \times NG : PN \times NQ :: TO \times OK : LO \times OI.$

Therefore, ex æquo, $PM \times MQ : PN \times NQ :: LO \times OI : LO \times OI$.

Consequently $PM \times MQ = PN \times NQ$; and $PM = QN$ (Lem. 2). Therefore the right line B C, which bisects D E and F G, will likewise bisect P Q (Lem. 1).

Def. 9. A right line which bisects two parallel right lines, both terminated by a conic section, or opposite sections, is called a diameter of the section, or opposite sections. This definition relates merely to the position of the diameters, and not to their magnitude.

Def. 10. The centre of an ellipse, or opposite hyperbolas, is a point in which is bisected every right line drawn through it, and terminated both ways by the ellipse, or opposite hyperbolas.

PROP. XII.

Fig. 21, 22. To find the centre of an ellipse, or opposite hyperbolas, given by position.

Draw two parallel right lines, as D E and F G, terminated both ways in the ellipse, or one hyperbola, or one of them in one hyperbola, and the other in the opposite hyperbola: draw the right line B C to bisect both the parallels D E and F G: then it is plain that B C will in all cases meet both the opposite hyperbolas; for it will bisect all the right lines that can be drawn in both, parallel to D E and F G (11.): let it meet the ellipse and opposite hyperbolas in B and C, and bisect B C in A, then is A the centre required.

Let H be a point in the ellipse, or one of the hyperbolas, and draw H L M parallel to D E or F G: take $AN = AL$, and draw P K through N parallel to D E or F G. — Then H M and K P terminated by the ellipse, or opposite hyperbolas, are bisected in L and N: and, because $BL \times LC = BN \times NC$, therefore $HL \times LM$, or $HL^2 = KN \times NP$, or KN^2 (Pr. 10):

therefore H L = K N; and it is plain that H A passes through K, and that H K is bisected in the centre A.

Cor. It follows from this proposition, that a right line drawn through the centre of two opposite hyperbolas from a point H in one of them will meet the other.

PROP. XIII.

Fig. 23. An ellipse, or opposite hyperbolas, have only one centre.

If there were two centres of an ellipse, then the right line drawn through them, and terminated by the periphery, would be bisected in two different points (12), which is absurd.

If it be possible, let A and D be both centres of two opposite hyperbolas, and from C, a point in one of the hyperbolas, draw C A B and C D F through A and D to meet the opposite hyperbola: also from B and F draw B D E and F A G to meet the first hyperbola, and join D A, G C, and C E. Because A and D are both centres, therefore B A = A C, and B D = D E, and C E is parallel to D A. In like manner, because F D = D C, and F A = A G, therefore C G is parallel to D A. Therefore G C and C E, drawn through the same point and parallel to the same line, make only one right line that meets a conic section in three points, which is absurd.

Cor. All the diameters of an ellipse, or opposite hyperbolas, intersect in the centre, and mutually bisect one another.

For if not, then there would be more than one centre.

PROP. XIV.

Fig. 24, 25, 26. Every right line drawn through the centre of an ellipse is a diameter; and every right line drawn through the centre of two opposite hyperbolas so as to be terminated by the opposite hyperbolas, or so as to be parallel to a right line terminated by one of the hyperbolas, is a diameter.

When a line drawn through the centre A of two opposite hyperbolas is parallel to H K (fig. 23), a line terminated in one hyperbola, draw the diameters H A G, F A K, and join F H and G K; and when a line drawn through the centre is terminated by an ellipse (fig. 24, 25), or opposite hyperbolas, draw H K parallel to it, and make the same construction as before. Because H A = A G, and K A = A F (Def. 10.) the two triangles F A H and G A K are equal in all respects, and it is manifest that F H and G K are parallel, and are bisected by the line through the centre parallel to H K: therefore that line is a diameter. (Def. 9.)

Cor. A right line drawn through the centre of an ellipse, or opposite hyperbolas which bisect one right line not passing through the centre, and terminated by the ellipse, or one of the hyperbolas, or both, will bisect all right lines terminated in the like manner, and parallel to the former line.

For the right line which bisects all the parallels passes through the centre: and therefore it must coincide with the line that bisects one of the parallels, and is drawn through the centre.

PROP. XV.

Fig. 27. All the diameters of a parabola are parallel to one another.

Let B C be a diameter of a parabola bisecting the lines D E and F G; take any point L within the parabola, and draw M N through it parallel to D E or F G, and terminated by the curve: then B C will bisect M N; and as this is true however remote from the lines D E and F G the line M N is drawn, it follows that the diameter B C cannot meet the curve in more than one point; and the same thing may be shewn of every other diameter as P Q. But all those right lines are parallel to one another which cut a parabola in one point only. (Cor. 2. Def. 6.)

Cor. A right line, parallel to a diameter of a parabola, which bisects one right line, terminated by the parabola, will bisect all other right lines parallel to the former and terminated by the parabola.

Def. 11. A diameter of two opposite hyperbolas, which is terminated by the two curves, is called a transverse diameter: and a diameter which meets neither of the curves is called a second diameter.

Def. 12. A vertex of a diameter is a point where the diameter meets the conic section.

The magnitude of a diameter, that meets a conic section or opposite sections in two points, is the line between the two vertices.

Def. 13. A right line, not passing through the centre, terminated by a conic section, or opposite sections, and bisected by a diameter, is said to be ordinately applied to that diameter: or, it is called a double ordinate, and the half it, an ordinate.

PROP. XVI.

Fig. 28. A right line, drawn from a vertex of a diameter of an ellipse, or a parabola, or from the vertex of a transverse diameter of a hyperbola, so as to be parallel to a line ordinately applied to that diameter, is a tangent of the curve.

Fig. 28. Let F H be a diameter of an ellipse or a parabola, or a transverse diameter of a hyperbola, and R S T, a line ordinately applied to that diameter; then F M, drawn from a vertex of the diameter, so as to be parallel to R T, is a tangent of the curve. For, if F M be not a tangent, it will cut the section again in another point (Cor. 2. Def. 8,) let it cut the section again in K, and bisect F K in I. Then, if a diameter of the section be drawn through I, that diameter would bisect R T parallel to F K, Pr. 15. Therefore R T would be bisected by two different diameters; *viz.* by the diameter F H, and by that drawn through I. But, in the ellipse and hyperbola, all the diameters pass through the centre; and, in the parabola, they are all parallel to one another; therefore two diameters of a conic section will cut every straight line (which does not pass through the centre of the ellipse and hyperbola) in two different points. Therefore R T cannot be bisected by two different diameters. Therefore F M, parallel to R T, does not cut the curve again; that is F M is a tangent of the conic section.

Cor. 1. If R T be ordinately applied to the diameter F H, it is parallel to a tangent, F M, at a vertex of that diameter.

For there cannot be two tangents of a conic section at the same point of the curve.

Cor. 2. All right lines ordinately applied to the same diameter of a conic section are parallel to one another.

For they are all parallel to a tangent at a vertex of that diameter.

PROP. XVII.

Fig. 29. A right line D E terminated both ways by the curve of a conic section, and parallel to a tangent F H, is ordinately applied to the diameter B C drawn through the point of contact B.

Take B F and B H, in the tangent on opposite sides of the point of contact, equal to one another, and of such a magnitude that lines drawn through F and H parallel to the diameter B C may cut the curve in K and L; join K L. It is plain that K L is bisected by B C: therefore K L is parallel to the tangent F H (Cor. 1, 16.); and consequently it is also parallel to D E (30. 1. E.); therefore D E is bisected by the same diameter which bisects K L (Cor. 14.)

Def. 14. Two diameters of an ellipse or of opposite hyperbolas, that are mutually parallel to one another's ordinate, are called conjugate diameters.

Cor. It is plain that two conjugate diameters of opposite hyperbolas cannot be both transverse, nor both second diameters.

PROP. XVIII.

Fig. 30 and 31. If a diameter of an ellipse, or of opposite hyperbolas, be parallel to the ordinates of another diameter, these two are conjugate diameters.

Let the diameter E D be parallel to P Q S an ordinate of the diameter F H; draw the diameter P R and join S R cutting E D in T. Because $PQ = QS$, and $PG = GR$; therefore S R is parallel to F H. And because E D is parallel to P Q S, and $PG = GR$; therefore $RT = TS$. Therefore R S is an ordinate of the diameter E D, and it is parallel to F H; therefore E D and F H are conjugate diameters, Def. 14.

Cor. If a diameter of an ellipse, as E D, be parallel to F O, a tangent at a vertex of another diameter F H; then F H is parallel to D I, a tangent at a vertex of E D.

For a tangent at a vertex of a diameter is parallel to the ordinates of that diameter.

PROP. XIX.

If a point be assumed without or within an ellipse, and two right lines, parallel to two diameters, be drawn from it to cut or touch the ellipse; then, as the rectangle under the segments of the secant, or the square of the tangent, parallel to one of the diameters, is to the rectangle under the segments of the secant, or the square of the tangent, parallel to the other diameter, so is the square of the first diameter to the square of the second diameter. And the same thing is true of two transverse diameters of opposite hyperbolas, and any two lines, parallel to these, drawn through a point to cut the two curves.

For diameters of an ellipse, and of opposite hyperbolas, are secants that intersect in the centre: and, because they are bisected there, this proposition is manifest from Pr. 10.

Def. 15. *Fig.* 32. Let a point, as O, be

assumed in the plane of two opposite hyperbolas, and let the secant O H K be drawn through it parallel to a transverse diameter B A; and the secants R O S, G O L, &c. parallel to any second diameters M N, P Q, &c.: in these diameters take the segments M N, P Q, &c. all bisected in the centre, such that the squares of M N, P Q, &c. may severally be to the square of the transverse diameters A B, as the rectangles R O $\times$ O S, G O $\times$ O H, &c. contained by the segments of the secants parallel to the second diameters are to K O $\times$ O H, the rectangle under the segments of the secant parallel to the transverse diameter: then the magnitudes of the second diameters are the segments M N, P Q, &c.

Because the ratios of the rectangles K O $\times$ O H, S O $\times$ O R, G O $\times$ O H, &c. are invariably the same wherever the point O is assumed, (10,) it is plain that the magnitudes of the second diameters M N, P Q, &c. are also invariably the same wherever the point O is assumed.

And because the ratio of the rectangles K O $\times$ O H to the square of the transverse diameter A B is the same as the ratio of the rectangle contained by the segments of any secant drawn through O parallel to a transverse diameter, to the square of the transverse diameter to which it is parallel, (19), it is also manifest that the magnitudes of the second diameters are the same from whatever transverse diameter they are deduced.

Cor. 1. And hence, taking the magnitudes of the transverse diameters as here defined, Prop. 19, may be enunciated for the hyperbola as generally as it is for the ellipse: that is, the rectangle under the segments of a secant, or the square of a tangent parallel to one diameter (whether a transverse or a second diameter) of opposite hyperbolas, is to the rectangle under the segments of a secant, or the square of a tangent, parallel to another diameter, as the square of the first diameter is to the square of the second diameter.

Cor. 2. If two tangents be drawn to an ellipse, or a hyperbola, or opposite hyperbolas, from the same point, then these tangents are proportional to the diameters, or semi-diameters, drawn parallel to the tangents.

For the squares of the tangents are proportional to the squares of the diameters.

Cor. 3. If a right line be ordinately applied to a diameter of an ellipse, or to a transverse diameter of a hyperbola; then as the square of the diameter is to the square of the conjugate diameter, so is the rectangle contained by the abscisses of the diameter, between the vertices and ordinate, to the square of the ordinate.

For the double-ordinate is bisected by the diameter, and it is parallel to the conjugate diameter.

PROP. XX.

Fig. 33. If an ordinate be drawn to a second diameter of opposite hyperbolas: the square of this second diameter is to the square of the conjugate diameter, as the sum of the squares of half the second diameter, and the part of it between the ordinate and the centre, is to the square of the ordinate.

Let A B and M N be conjugate diameters of opposite hyperbolas, H K an ordinate to the second diameter M N, and draw K D S parallel to M N: then K D S is ordinately applied to A B (18.); therefore

$M C^2 : C B^2 :: K R^2$, or $C L^2 : A D \times D B$, or $C D^2 - C B^2$ (Cor. 3. Def. 15.) therefore, $M C^2 : C B^2 :: M C^2 + C L^2 : C D^2$, or $K L^2$.

PROP. XXI.

Fig. 34. If two parallel lines be drawn from two points in the diameter of a parabola to cut or touch the curve: then as the rectangle under the segments of the secant, or the square of the tangent, drawn from one point, is to the rectangle under the segment of the secant, or the square of the tangent drawn from the other point, so is the abscissa of the diameter between the first point and the curve to the abscissa between the second point and the curve.

Let the parallel secants M N and P Q meet the diameter of a parabola in D and E: it has been shewn (Prop. 15.) that the diameters of a parabola meet the curve only in one point; and therefore (Cor. 1st. Def. 7.) they are all parallel to a line in the surface of the cone by the section of which the parabola is produced (*viz.* to the line V B (fig. 13.) in which the touching plane, parallel to the plane of the parabola, meets the conic surface): therefore Prop. 8.

$M D \times D N : P E \times E Q :: B D : B E.$

Cor. 1. The squares of the ordinates drawn to a diameter of a parabola are proportional to the abscissas of the diameter between the ordinates and the vertex.

For the double ordinates R D G and

HEK are parallel to one another: therefore by this proposition,

$RD \times DG$, or $RD^2 : HE \times EK$ or $HE^2 :: BD : BE$.

Cor. 2. If the square of one ordinate, of the diameter of a parabola, as RD, be made equal to a rectangle contained by the corresponding abscissa BD and the line P: then, it is manifest from the last corollary, that the square of any other ordinate of the same diameter, as HE, will be equal to a rectangle under the corresponding abscissa BE, and the same line P.

The line P is called the parameter of the diameter to which the ordinates are drawn.

Fig. 35. *Def.* 16. If two right lines, as GCS and FCT, be drawn through the centre of two opposite hyperbolas, so as to be parallel to the two lines in the conic surface, which are the intersections of that surface, and a plane drawn through the vertex of the cone, parallel to the plane of the hyperbolas, (*viz.* to the lines V*m* and V*n*, in fig. 14): these two lines GS and FT are called the asymptotes of the hyperbolas.

Cor. 1. Every line drawn through the centre, within the angles of the asymptotes that are turned to the hyperbolas, is a transverse diameter: and every line drawn through the centre within the adjacent angle is a second diameter.

For the former lines are parallel to lines (such as VO in fig. 14.) drawn within the cone in the angle contained by the two lines (*m*V and *n*V, fig. 14.) in the conic surface, that are parallel to the asymptotes; and the latter lines are parallel to lines (such as RVS, fig. 14.) without the cone: whence the truth of the corollary is manifest by Cor. 2, Def. 7. and Prop. 14.

PROP. XXII.

The asymptotes do not meet either of the opposite hyperbolas.

For if an asymptote be supposed to meet one of the hyperbolas, being drawn through the centre, it will likewise meet the other hyperbola (Cor. 12): and thus a line, drawn parallel to a line contained in the surface of a cone, would meet both the opposite conic surfaces, which is impossible (Pr. 2.)

PROP. XXIII.

Fig. 35 and 36. If a point be assumed without a hyperbola, but within the asymptotes, and a right line be drawn from it to touch or cut the hyperbola, or opposite hyperbolas: then the square of the tangent, or the rectangle under the segments of the secant, is less than the square of the semi-diameter parallel to the tangent or secant; but if the point be assumed without both the hyperbola and the asymptotes, the square of the tangent, or the rectangle under the segments of the secant, is greater than the square of the semi-diameter parallel to the tangent or secant.

First, let the point P be without the hyperbola, and within the asymptotes, and let PH, (fig. 35.) parallel to the semi-diameter CD touch the hyperbola; because P is a point within the asymptotes, the line drawn from it through the centre will be a transverse diameter: thus,

$CE^2 : CD^2 :: EP \times PK : PH^2$ (19 and Cor. 1. Def. 15.)

But CE^2 is greater than $EP \times PK$; therefore CD^2 is greater than PH^2. And in like manner may the proposition be demonstrated when the line drawn from P does not touch, but cuts the hyperbola, or opposite hyperbolas.

Next, let P be without the asymptotes: draw RS (fig. 36), terminated by one of the hyperbolas parallel to CP, the line drawn from P to the centre: draw the diameter CE to bisect RS and MN through P parallel to CE. Because the diameter CE bisects RS parallel to CP, therefore MN, parallel to CE, is ordinately applied to the second diameter CP (18). Let CQ be the magnitude of this semidiameter, then

$CQ^2 : CE^2 :: CQ^2 + CP^2 : PN^2$ (20)

And $CE^2 : CD^2 :: MP \times PN$, or $PN^2 : PH^2$

Ex equo, $CQ^2 : CD^2 :: CQ^2 + CP : PH^2$. But $CQ^2 + CP^2$ is greater than CQ^2, therefore PH^2 is greater CD^2. And in like manner may the proposition be proved, when the line drawn through P does not touch, but cuts a hyperbola, or opposite hyperbolas.

PROP. XXIV.

Fig. 37, 38. If from a point (P or Q) in an asymptote of a right line be drawn to touch or cut the hyperbola, or opposite hyperbolas (PH or QRS): the square of the tangent, or the rectangle under the segments of the secant (PH^2 or $QR \times QS$) is equal to the square of the semidiameter (CD^2) parallel to the tangent or secant.

For if not, make HO^2 and $RO^1 \times O^1S$ equal to CD^2: then O and O^1 are without the hyperbola, and they must be either within the asymptotes or without them. In the former case HO^2 and $RO^1 \times O^1S$ would be less than CD^2 (23.); and in the latter case HO^2 and $RO^1 \times O^1S$ would be

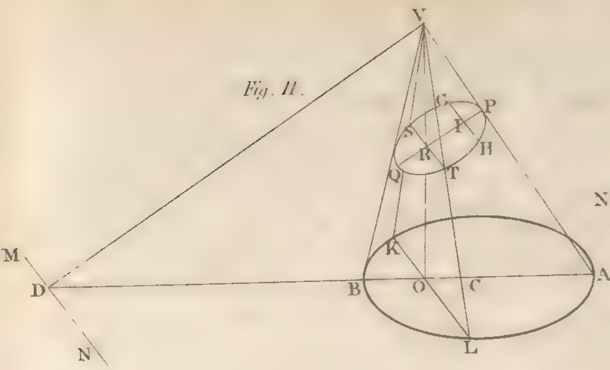


Fig. 11.

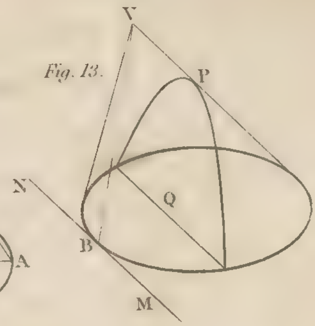


Fig. 13.

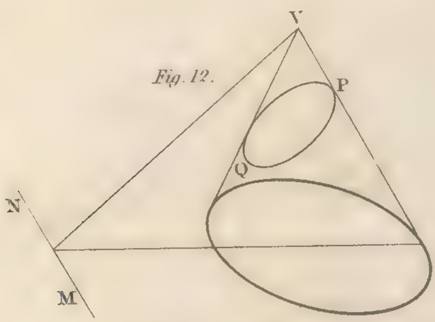


Fig. 12.

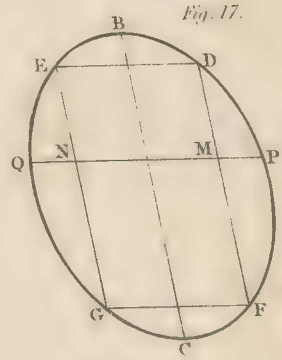


Fig. 17.

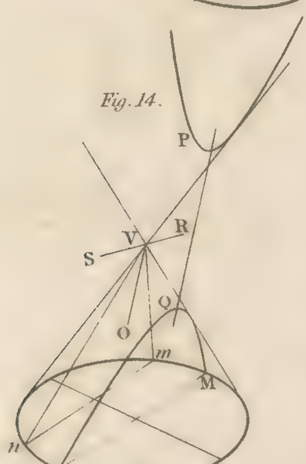


Fig. 14.

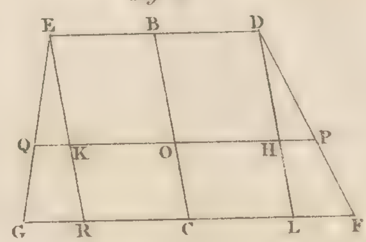


Fig. 15.

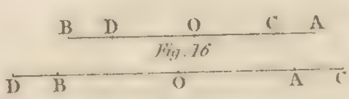


Fig. 16

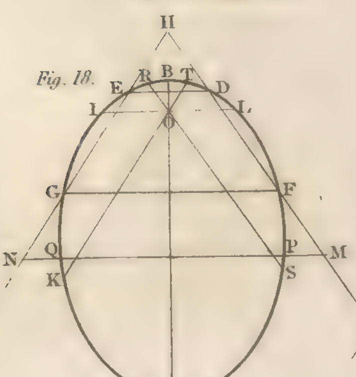


Fig. 18.

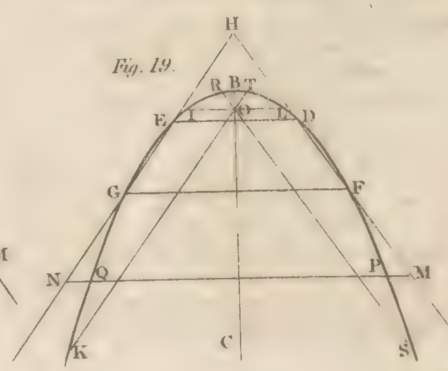


Fig. 19.

Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, June. 1808.

Fig. 20.

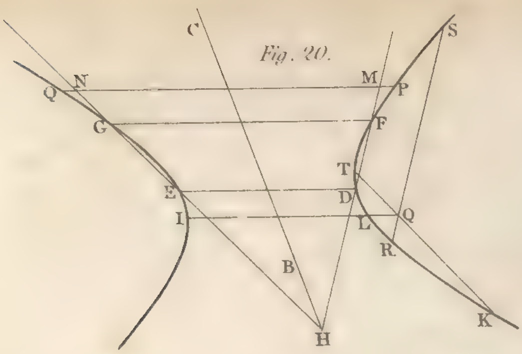


Fig. 21.

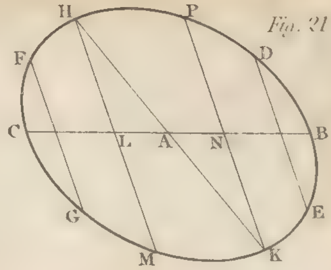


Fig. 22.

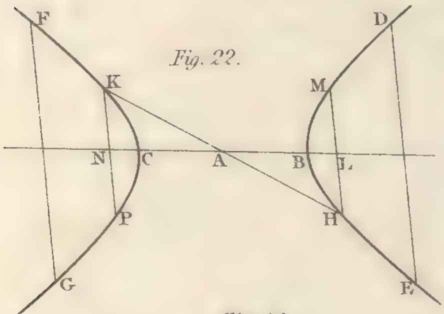


Fig. 23.

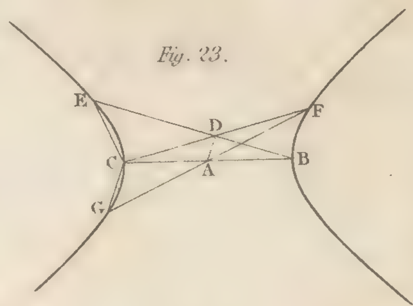


Fig. 24.

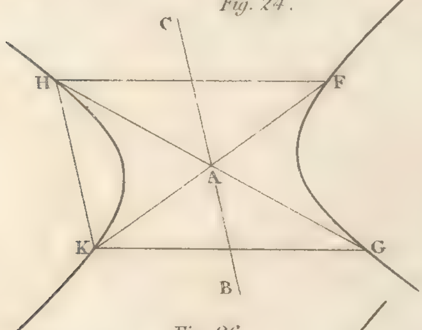


Fig. 25.

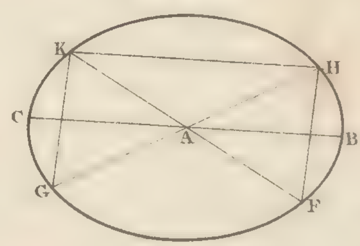


Fig. 26.

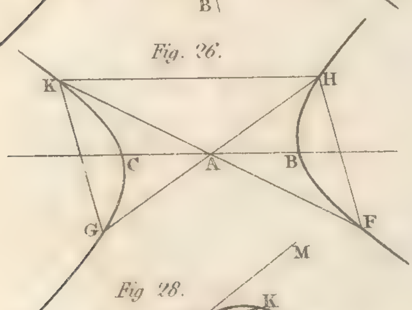


Fig. 27.

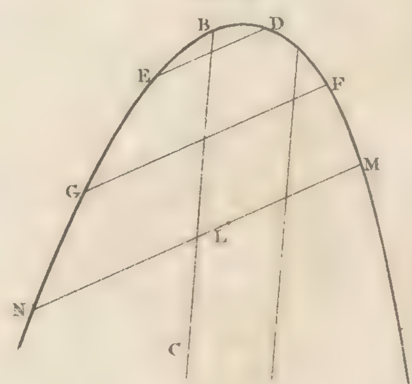
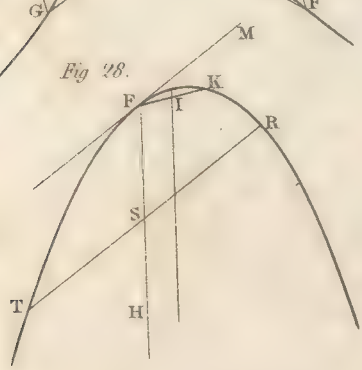
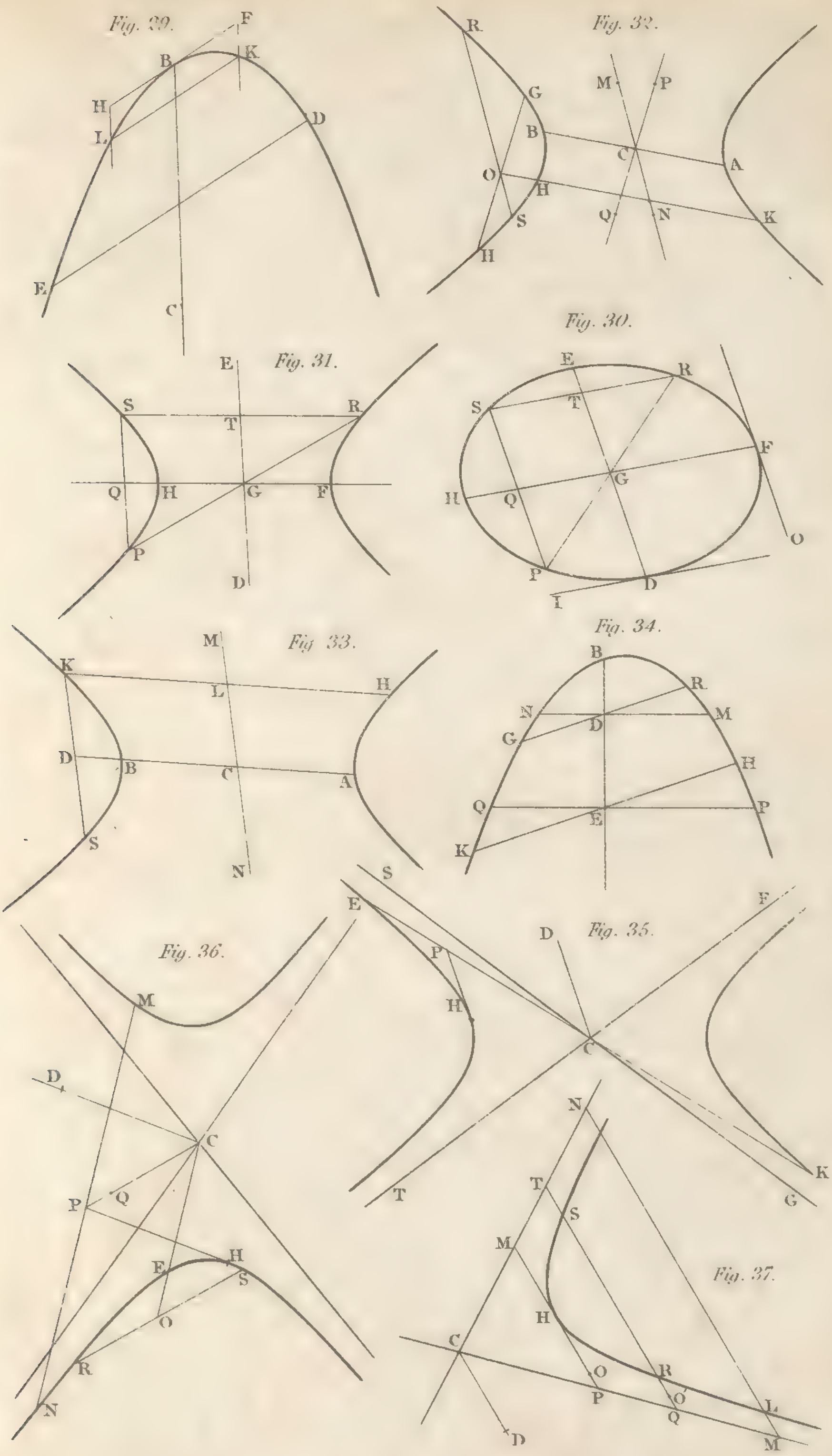


Fig 28.



Lowry sculp.

London Published by Longman Hurst, Rees & Orme, June 1808.



Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, June 1808.

greater than CD^2 (23.), which are equally absurd. Therefore PH^2 and $QR \times QS$ are equal to CD^2.

Cor. 1. If a tangent of a hyperbola meet both asymptotes, as PM, the segments PH and HM between the asymptotes and the point of contact are equal. And if a right line cut a hyperbola, or opposite hyperbolas, and both the asymptotes, as QT, the segments between the curve or curves, and the asymptotes are equal to one another: that is $QR = TS$, and $QS = TR$.

For PH^2, HM^2, $QR \times QS$, and $TR \times TS$, are all equal to CD^2.

Cor. 2. On the contrary, if PM, intercepted between the asymptotes, meet the hyperbola in H, and is bisected there; then PM is a tangent of the hyperbola.

Cor. 3. If any number of lines all parallel to one another, as QT and MN, cut a hyperbola and the asymptotes, the rectangles $QR \times RT$, $ML \times LN$, under the segments between the curve and the asymptotes are all equal.

For it is plain (Cor. 1.) that the rectangles are all equal to CD^2.

Def. 17. A diameter of a conic section that cuts its ordinates at right angles is called an axis.

Cor. Because two conjugate diameters of an ellipse, and opposite hyperbolas, cut their ordinates in the same angles, Pr. 18; therefore, if there be one axis of these curves, there will necessarily be two, and these will be conjugate diameters, and they will cut one another at right angles.

PROP. XXV.

Fig. 39, 40. An ellipse, and opposite hyperbolas, have two axes.

Find the centre of the ellipse C (fig. 39.), and draw two diameters.

Then if the two diameters be equal to one another, as EF and DI, two other diameters, AB and GH, drawn to bisect the angles contained by DI and EF, will be axes of the ellipse. Join ED and DF: then the lines AB and GH which bisect the vertical angles of the isosceles triangles FCD and ECD, will bisect the bases DE and DF, and likewise cut these lines at right angles. Hence it is plain that AB and GH are conjugate diameters and axes of the ellipse.

But if the two diameters be not equal, as MN and PQ, describe a circle from the centre C with a radius less than the greater semidiameter CM, but greater than the less semidiameter CP: then the circle will cut the diameter MN on both sides of the centre within the ellipse, and it will be without the ellipse towards the point P: therefore the circle will cut the periphery of the ellipse both between P and M, and between P and N: let E and D be the points of section; then two diameters drawn through them will be equal, and the axes of the ellipse will be found as above.

In the case of opposite hyperbolas, (fig. 39.) find the centre C, and from C as a centre describe a circle through a point within one of the hyperbolas: then that circle will cut the hyperbola in two points D and E, and two transverse diameters drawn through these will be equal to one another; and two diameters AB and GH drawn to bisect the angles comprehended by the equal diameters DI and EF will be conjugate diameters and axes of the hyperbolas. The demonstration is the same as for the ellipse.

PROP. XXVI.

Fig. 41 and 42. The two axes of an ellipse are always unequal; and the greater axis is the greatest diameter, and the less axis the least diameter of the curve. And that axis of a hyperbola, which is a transverse diameter, is the least of all the transverse diameters.

Let AB and DE (Fig. 41) be the two axes of an ellipse, C the centre, and CH any semidiameter; draw HP perpendicular to AB, and HQ perpendicular to DE. Because AB and DE are conjugate diameters; and HP an ordinate to AB, and HQ an ordinate to DE; therefore,

$AB^2 : DE^2 :: AP \times PB : HP^2$, Cor. 3, Def. 15.

Now, if AB be supposed to be equal to DE, it will follow that $AP \times PB = HP^2$; therefore, $AP \times PB + CP^2 = HP^2 + CP^2$, or $AC^2 = CH^2$. Therefore, $AC = CH$: and the ellipse will be a circle, which is not the case, Cor. 9. Therefore, AB and DE are unequal; let AB be supposed to be greater than DE.

Because AB^2 is greater than DE^2, therefore $AP \times PB$ is greater than HP^2; and $AP \times PB + CP^2$, or AC^2, is greater than $HP^2 + PC^2$, or CH^2. Therefore the semiaxis AC is greater than any other semidiameter HC.

In like manner.

$DE^2 : AB^2 :: DQ \times QE : HQ^2$.

Therefore $DQ \times QE$ is less than HQ^2; and $DQ \times QE + CQ^2$, or CD^2, is less than $HQ^2 + CQ^2$, or CH^2. Therefore the

semi-axis D C is less than any other semi-diameter C H.

Fig. 42. In the hyperbola, a tangent of the curve drawn from the extremity of the axis C A, as A T, falls between the centre and the curve; and because C A, the semi-axis, is less than any other line drawn from C to A T, much more is it less than a semi-diameter C H drawn from C to the curve on the other side of A T.

Cor. Hence it is plain, that an ellipse, or opposite hyperbolas, have only two axes.

Def. 17. The greater axis of an ellipse is called the transverse axis; and the less, the conjugate axis; and, in the hyperbola, that one is the transverse axis which is a transverse diameter, and the other is the conjugate axis.

PROP. XXVII.

Fig. 41 and 42. A diameter of an ellipse nearer the transverse axis is greater than one more remote; and a transverse diameter of the hyperbola nearer the transverse axis is less than one more remote.

Let C K and C H (fig. 41.) be two semi-diameters of an ellipse; join H K, and draw A G parallel to H K; join C G and draw C L to bisect H K. Because C L bisects H K, it will likewise bisect A G. Cor. 14. And because $AM = MG$, and A C is greater than C G, therefore the angle A M C is greater than the angle G M C, (25. 1. E); that is, the angle K L C is greater than the angle H L C. And because $HL = LK$, therefore K C, nearer to C A, is greater than H C more remote from C A, 24. 1. E.

In the hyperbola, the same construction being made, because A C is less than C G, therefore the angle A M C, or K L C, is less than the angle G M C, or H L C. Therefore C K is less than C H.

PROP. XXVIII.

Fig. 43. A parabola has only one axis.

Let O S, terminated by the curve, be perpendicular to any diameter, and draw the diameter P Q to bisect O S, and, because all the diameters of the curve are parallel, therefore P Q is perpendicular to O S, and an axis of the curve, Def. 17. And because O S can be an ordinate of only one diameter, therefore there is only one axis.

Def. 19. *Fig.* 44, 45, and 46. Let A B (fig. 44 and 46.) be the transverse axis, D E the conjugate axis, and C the centre of an ellipse, or hyperbola, or opposite hyperbolas: and let C F and C f be taken in the transverse axis, such that CF^2 and Cf^2 are each equal to $CA^2 - CD^2$ in the ellipse, and to $CA^2 + CD^2$ in the hyperbola; then the two points F and f are called the foci of the ellipse, hyperbola, or opposite hyperbolas.

But the focus of a parabola (fig. 45.) is a point F in the axis within the curve, and distant from the vertex by a line equal to one fourth part of the parameter of the axis.

Cor. The distance of each foci of an ellipse from either extremity of the conjugate axis is equal to half the transverse axis; and the distance of either of the foci of a hyperbola from the centre is equal to the distance between the extremities of the transverse and conjugated axes.

Def. 20. If F (fig. 44 and 46) be a focus of an ellipse, or hyperbola, or opposite hyperbolas, and A G be taken in the transverse axis (on the opposite side of the vertex to the focus F), such, that A F is to A G as C F is to C A; then a line, as H K, drawn through G perpendicular to the transverse axis, is called a directrix of the ellipse, or hyperbola, or opposite hyperbolas.

Fig. 45. But the directrix of a parabola is a line, as H K, perpendicular to the axis, drawn through a point G as far distant from the vertex of the axis on the one side as the focus is on the other side.

Cor. An ellipse, hyperbola, or opposite hyperbolas, have two directrices; one corresponding to each focus. For the same construction that is made for one focus may be made for the other focus.

PROP. XXIX.

Fig. 44 and 46. Let A B be the transverse, and D E the conjugate axis of an ellipse, or hyperbola, or opposite hyperbolas; from any point in the curve, or opposite curves, as M, let M C be drawn to the centre, and M P perpendicular to the transverse axis, and take C O in the same axis, such that CO^2 may be equal to $MC^2 - CD^2$ in the ellipse, and to $MC^2 + CD^2$ in the hyperbola; then as A C is to C F so is P C to C O.

For, because A B and D E are conjugate diameters, therefore,

$AC^2 : CD^2 :: AP \times PB : MP^2$, (Cor. 3. Def. 15.) therefore, $AC^2 : AC^2 \mp CD^2 :: AP \times PB : AP \times PB \mp MP^2$. But in the ellipse $AC^2 - CD^2 = CF^2$; and $AP \times$

Fig. 38.

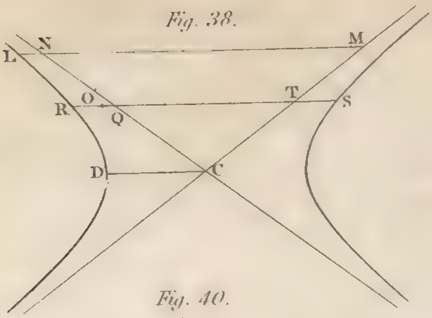


Fig. 39.

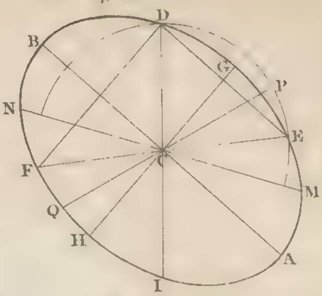


Fig. 40.

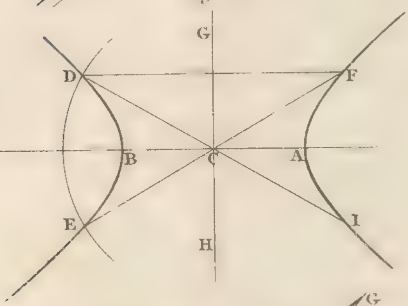


Fig. 41.

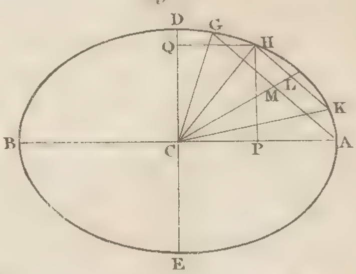


Fig. 42.

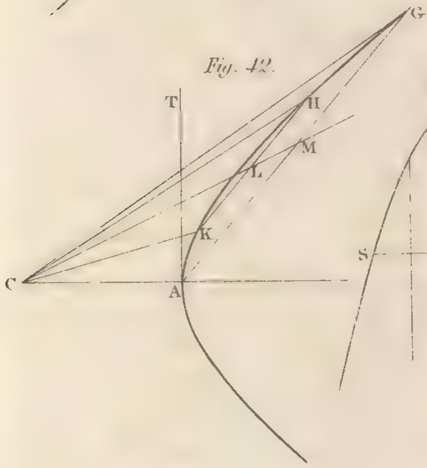


Fig. 43.

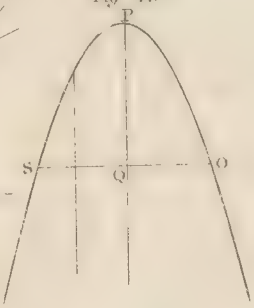


Fig. 45.

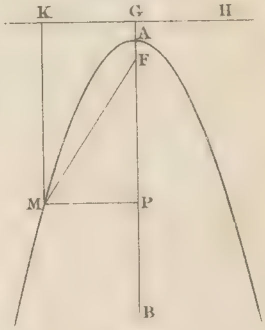


Fig. 46.

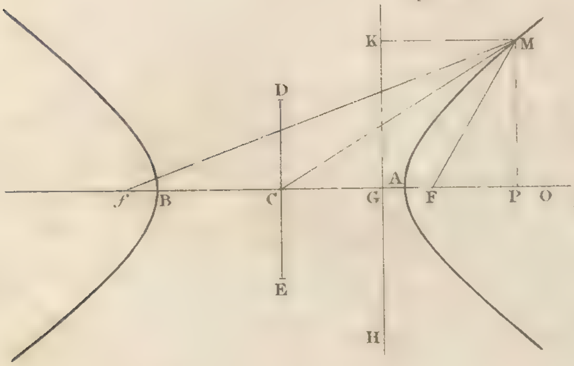
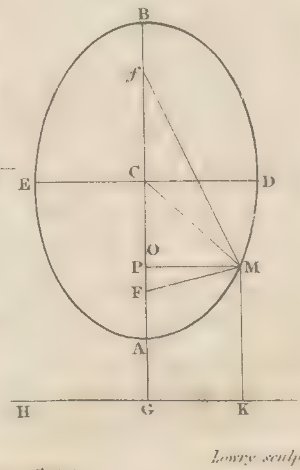


Fig. 44.



Lowry sculp.

London. Published by Longman, Hurst, Rees & Orme, June 1st 1808.

$PB - MP^2 = AC^2 - CP^2 - MP^2 = AC^2 - MC^2 = AC^2 - CD^2 - CO^2 = CF^2 - CO^2$: and, in the hyperbola, $AC^2 + CD^2 = CF^2$; and $AP \times PB + MP^2 = PC^2 - AC^2 + MP^2 = MC^2 - AC^2 = CO^2 - CD^2 - CA^2 = CO^2 - CF^2$. Therefore, the last analogy becomes,

$AC^2 : CF^2 :: AC^2 \mp CP^2 : CF^2 \mp CO^2$

Consequently, $AC^2 : CF^2 :: CP^2 : CO^2$ 19. 5. E.

And, $AC : CF :: CP : CO$.

PROP. XXX.

Fig. 44 and 46. If M be a point in an ellipse or hyperbola, and MF and M*f* be drawn to the foci; then, in the ellipse, the sum of MF and M*f* is equal to the transverse axis; and, in the hyperbola the difference of MF and M*f* is equal to the transverse axis.

Draw MP perpendicular to the transverse axis, and take CO as in the last proposition. And, because

$AC : CF :: CP : CO$, Pr. 29.

Therefore, $AC \times CO = FC \times CP$; and $4AC \times CO = 4CF \times FO$. But, because AB and F*f* are bisected in C, therefore $4AC \times CO = BO^2 - AO^2$, 8. 2. E. and $4FC \times CP = Pf^2 - PF^2 = fM^2 - MF^2$, 47. 1. E; therefore $BO^2 - AO^2 = fM^2 - MF^2$.

Again, $MF^2 + Mf^2 = fP^2 + FP^2 + 2MP^2 = 2FC^2 + 2CP^2 + 2MP^2 = 2FC^2 + 2MC^2 = 2FC^2 \pm 2CD^2 + 2CO^2 = 2AC^2 + 2CO^2 = BO^2 + AO^2$.

And, because $BO^2 + AO^2 = fM^2 + MF^2$, and $BO^2 - AO^2 = fM^2 - MF^2$; therefore, by adding the equals, $2BO^2 = 2fM^2$; and, by substracting the equals, $2MF^2 = 2AO^2$. Therefore $fM = BO$, and $FM = AO$; whence the proposition is manifest.

PROP. XXXI.

Fig. 44, 45, and 46. A straight line drawn from any point in a conic section to a focus has to a perpendicular drawn to the corresponding directrix, a ratio that is constantly the same wherever the point is assumed in the curve; and, in the ellipse, the constant ratio is a ratio of minority (or of a less magnitude to a greater); in the hyperbola the constant ratio is a ratio of majority (or of a greater magnitude to a less); and, in the parabola the constant ratio is a ratio of equality.

Let M (fig. 44 and 46) be a point in an ellipse or hyperbola, and draw MF to a focus, and MK perpendicular to the directrix HG, which corresponds to that focus, draw MP perpendicular to the transverse axis, and take CO as in Prop. 29. Then

$AC : CF :: CP : CO$, Pr. 29.

Invertendo, $CF : CA :: CO : CP$

Therefore, $CF : CA :: FO : AP$, 19. 5. E.

But, $CF : CA :: AF : AG$, Def. XX.

Therefore, $CF : CA :: AO : GP$, 12. 5. E.

But, as has been shewn in the demonstration of the last proposition, $AO = MF$, and $GP = MK$; therefore

$CF : CA :: MF : MK$.

But the ratio of CF to CA is a constant ratio; and it is a ratio of minority in the ellipse, and a ratio of majority in the hyperbola.

Fig. 45. In the parabola, $GA = AF$, and $4AF \times AP = MP^2$, Def. 1.; but $4AF \times AP = GP^2 - PF^2$, 8. 2. E; therefore $MP^2 = GP^2 - PF^2$; and $MP^2 + PF^2$, or $MF^2 = GP^2$, or MK^2. Therefore $MF = MK$.

CONIFERÆ, in botany, the name of one of the orders of Linnæus's fragments of a natural method, consisting of plants whose female flowers, placed at a distance from the male either on the same or distinct roots, are formed into a cone. Of this order are the Abies, Cypressus, &c.

All the coniferæ yield a resin which renders most of them evergreen. The fruit in all is biennial, being produced in the spring, but not ripening and dropping its seeds until spring after. The coniferæ compose also one of the natural orders of Jussieu.

CONIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Umbellatæ. Essential character: partial involucre halved, three-leaved; fruit nearly globular, five-streaked, notched on each side. There are five species of which C. maculatum, common hemlock, is obviously distinguished by its large and spotted stalk; by the dark-green shining leaves; and particularly by their disagreeable smell when bruised. The root is biennial, resembling that of a small parsnep. The stem is from four to six feet high, hollow, and covered with a blueish powder, which easily wipes off. The leaves which grow near the bottom of the plant are about two feet in length. Calyx entire; corolla white, outer petals largest; seeds brownish, resembling those of aniseed.

CONJUGATE *diameter*, or *axis of an ellipsis*, the shortest of the two diameters, or that bisecting the transverse axis.

CONJUGATE *hyperbolas*. See CONIC SECTIONS.

CONJUGATION, in grammar, a regular distribution of the several inflexions of verbs in their different voices, moods, tenses, numbers and persons, so as to distinguish them from one another.

CONJUNCT, or CONJOINT. See the article CONJOINT.

CONJUNCTION, in astronomy, the meeting of two stars or planets, in the same degree of the zodiac. This conjunction is either true or apparent. The true conjunction is when a right line, drawn from the eye through the centre of one of the bodies, would pass through that of the other: in this case the bodies are in the same degree of longitude and latitude: and here the conjunction is also said to be central, if the same line, continued from the two centres through the eye, do also pass through the centre of the earth.

Apparent conjunction, is when the two bodies do not meet precisely in the same point, but are joined with some latitude. In this case a right line, drawn through the centre of the two bodies, would not pass through the centre of the earth, but through the eye of the spectator.

The moon is in conjunction with the sun, when they meet in the same point of the ecliptic, which happens every month; and eclipses of the sun are always occasioned by the conjunction of the sun and moon in or near the nodes of the ecliptic.

CONJUNCTION, in grammar, an undeclinable word or particle, which serves to join words and sentences together, and thereby shews their relation or dependence one upon another.

CONJURATION, strictly means combining together by oath, especially with evil spirits to do a public harm. The using of witchcraft, conjuration, &c. was felony by 1. Jac. c. 12. but that was repealed by the 9. Geo. II. c. 5. and the offences and all prosecutions for them abolished, but if any pretend to witchcraft, or conjuration, or to tell fortunes, or from skill in occult or crafty science, to discover goods or chattels supposed, they shall be imprisoned a year, and stand in the pillory once a quarter, and may be ordered to give security for good behaviour.

CONNARUS, in botany, a genus of the Monadelphia Decandria class and order. Natural order of Dumosæ. Terebintaceæ Jussieu. Essential character: style one, stigma simple; capsules two-valved, one-celled, one-seeded. There are four species, natives of warm climates.

CONOCARPUS, in botany, Jamaica button tree, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Elæagni Jussieu. Essential character: petals five, or none; calyx, bell form; seeds naked, solitary, inferior; flowers aggregate. There are three species found in the West Indies, where the natives use the bark for tanning leather.

CONOID, in geometry, a solid body, generated by the revolution of a conic section about its axis.

CONOPEA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Lysimachiæ. Jussieu. Essential character: calyx five-cleft; corolla ringent, two-lipped, lower-lip trifid; stigma two-lobed; capsule one-celled, four-valved, many-seeded. There is but one species, *viz.* C. aquatica, a native of Guiana, flowering in June.

CONOPS, in natural history, a genus of insects of the order Diptera. Generic character: mouth with a projecting geniculate proboscis; antennæ clavate and pointed at the end. There are 22 species in two sections. A. sucker, geniculate near the base, with a single-valved, abbreviated sheath, inclosing a single bristle. B. sucker, geniculate at the base and middle, the sheath with two equal valves. The insects of this genus are remarkably active, and are found in gardens, where they subsist on the nectarious juices of flowers: their larvæ are not known. In the true conops the head is large and nearly hemispherical; the eyes large and almost oval; and the antennæ formed of three articulations, the middle one of which is long and cylindrical, the last joint terminating in a little point.

CONSANGUINITY, the relation subsisting between persons of the same blood, or who are sprung from the same root.

Consanguinity terminates in the sixth and seventh degree, excepting in the succession of the crown, in which case it is continued to infinity.

Marriage is prohibited by the church to the fourth degree of consanguinity inclusive; but by the law of nature, consanguinity is no obstacle to marriage, except it be in the direct line.

CONSCIENCE, in ethics, a secret testimony of the soul, whereby it gives its approbation to things that are naturally good, and condemns those that are evil.

CONSCRIPTS, men raised to recruit the French armies. All men capable of bearing arms in France and its dependencies

are registered, and when called upon by the government, are obliged to join the army on any service.

CONSEQUENCE, in logic, the conclusion, or what results from reason or argument.

CONSEQUENT *of a ratio*, in mathematics, the latter of the two terms of a ratio, or that to which the antecedent is compared; thus is $m:n$, or m to n, n is the consequent, and m the antecedent.

CONSERVATOR, an officer ordained for the security and preservation of the privileges of some cities and communities, having a commission to judge of and determine the differences among them.

CONSERVATOR *of the peace*, in our ancient customs, a person who had a special charge to keep the king's peace. Till the appointment of justices of the peace by Edward III., there were several persons, who, by common law, were interested in keeping the same: some having that charge as incident to other offices, and others called conservators of the peace. Those that were so by virtue of their office still continue, but the latter are superseded by the modern justices. The chamberlain of Chester is still a conservator in that county; and petty constables are, by the common law, conservators, &c. of the king's peace. The king's majesty is, by his office and dignity royal, the principal conservator of the peace within all his dominions, and may give authority to any other to see the peace kept, and to punish such as break it, hence it is usually called the king's peace.

CONSERVATORY, a term sometimes used for a green-house, or ice-house.

CONSERVE, a form of medicine. See PHARMACY.

CONSIDERATION, in law, the material cause or ground of a contract, without which the party contracting would not be bound. Consideration in contracts, is something given in exchange, something that is mutual and reciprocal; as money given for goods sold, work performed for wages. And a consideration of some sort or other is so absolutely necessary to the forming a contract, that a *nudum pactum*, or agreement to do or pay any thing on one side, without any compensation on the other, is totally void in law; and a man cannot be compelled to perform it. A consideration is necessary to create a debt.

CONSIGNMENT, in law, the depositing any sum of money, bills, papers, or commodities in good hands; either by appointment of a court of justice, in order to be delivered to the persons to whom they are adjudged; or voluntary, in order to their being remitted to the persons they belong to, or sent to the places they are designed for. Consigned goods are supposed in general, to be the property of him by whom they were consigned, but to be at the disposal of him to whom they are consigned.

CONSISTORY, a tribunal; every archbishop and bishop of every diocese hath a consistory court, held before his chancellor or commissary in his cathedral church, or other convenient place of his diocese, for ecclesiastical causes. From the bishop's court the appeal is to the archbishop; from the archbishop's court to the delegates.

CONSONANCE, in music, is ordinarily used in the same sense with concord, *viz.* for the union or agreement of two sounds produced at the same time, the one grave, and the other acute; which mingling in the air in a certain proportion, occasion an accord agreeable to the ear.

CONSONANT, a letter that cannot be sounded without some single or double vowel before or after it.

Consonants are first divided into single and double; the double are *x* and *z*, the rest are all single: and these are again divided into mutes, and liquids, eleven mutes, *b*, *c*, *d*, *f*, *v*, *g*, *j*, *k*, *p*, *q*, *t*; and four liquids, *l*, *m*, *n*, *r*. But the most natural division of consonants, is that of the Hebrew grammarians, who have been imitated by the grammarians of other Oriental languages. These divide the consonants into five classes, with regard to the five principal organs of the voice, which all contribute, it is true, but one more notably than the rest, to certain modifications, which make five general kinds of consonants. Each class comprehends several consonants, which result from the different degrees of the same modification, or from the different motions of the same organs: these organs are the throat, palate, tongue, teeth, lips, whence the five classes of consonants are denominated guttural, palatal, lingual, dental, and labial.

CONSPIRACY, in law, signifies an agreement between two or more, falsely to indict, or procure to be indicted, an innocent person of felony.

CONSPIRATORS are, by statute, defined to be such as bind themselves by oath, covenant, or other alliance, to assist one another, falsely and maliciously to indict persons, or falsely to maintain pleas.

From this and the former article it seems to follow, that not only those who actually

cause an innocent man to be indicted, and also to be tried upon the indictment, whereupon he is lawfully acquitted, are properly conspirators; but that those also are guilty of this offence who basely conspire to indict a man falsely and maliciously, whether they do any act in prosecution of such confederacy or not. For this offence the conspirators, may be indicted at the suit of the king, and may be sentenced to fine, imprisonment, and pillory.

CONSTABLE. Lord high constable, an ancient officer of the crowns both of England and France, whose authority was so very extensive, that the office has been laid aside in both kingdoms, except upon particular occasions, such as the king's coronation.

The function of the constable of England consisted in the care of the common peace of the land, in deeds of arms and matters of war. By a law of Richard II. the constable of England has the determination of things concerning wars and blazonry of arms, which cannot be discussed by the common law. The first constable was created by the Conqueror: the office continued hereditary till the 13th of Henry VIII. when it was laid aside, as being so powerful as to become troublesome to the king. We have also constables denominated from particular places, as constable of the Tower, of Dover Castle, of Windsor Castle, of the castle of Caernarvon, and many other of the castles of Wales, whose office is the same with that of the castellani, or governors of castles.

From the lord high constable are derived those inferior ones, since called the constables of hundreds or franchises, who were first ordained in the thirteenth of Edward I. by the statute of Winchester, which, for the conservation of peace and view of armour, appointed that two constables should be chosen in every hundred. These are what we now call high constables, on account that the increase of people and offences has made it necessary to appoint others under these, in every town, called petty constables, who are of the like nature, though of inferior authority to the other. The high constable over the whole hundred is usually chosen and sworn into his office by the justices of the peace, in their sessions: and as to petty constables in towns, villages, &c. the right of choosing them belongs to the court-leet, though they may be elected by the parishioners. They are appointed yearly, and ought to be men of honesty, knowledge, and ability; and if they refuse to serve, or do not perform their duty, they may be bound over to the sessions, and there indicted and fined. Any constable, without a warrant from a justice, may take into his custody any persons that he sees committing felony, or breaking the peace; but if it be out of his sight, as where a person is seized by another, he cannot do it without a warrant.

There are many persons exempted by law from serving the office of constable: these are the ancient officers of any of the colleges in the two universities, counsellors, attornies, and all other officers whose attendance is required in the courts of Westminster-hall, aldermen of London, the president and fellows of the fellowship of physic in London, surgeons and apothecaries in London, and within seven miles thereof, being free of the company of apothecaries, and licensed teachers, or preachers in holy orders, in a congregation legally tolerated, shall be exempted from the office of a constable. The prosecutor of a felon to conviction, or the person to whom he shall assign the certificate thereof, shall be discharged from the office of constable.

But generally speaking, every housekeeper, inhabitant of the parish, and of full age, is liable to fill the office of constable: he ought, however, to be of the abler sort of parishioners, as being more likely to perform his duty with probity and discretion.

CONSTELLATION, in astronomy, a system of several stars that are seen in the heavens near to one another. Astronomers not only mark out the stars, but, that they may better bring them into order, they distinguish them by their situation and position in respect to each other; and therefore they distribute them into asterisms, or constellations, allowing several stars to make up one constellation: and for the better distinguishing and observing them they reduce the constellations to the forms of animals, as men, bulls, bears, &c. or to the images of some things known, as of a crown, a harp, a balance, &c, or give them the names of those whose memories, in consideration of some notable exploit, they had a mind to transmit to future ages. See ASTRONOMY.

CONSTITUTION, in matters of policy, signifies the form of government established in any country or kingdom.

The constitution and government of a country frequently differ, though the latter should be founded on the former in every particular. The two terms are considered by some persons as synonymous, but accu-

rate writers have ever made the necessary distinction between them. Lord Bolingbroke defines a constitution to be a general system of laws, institutions, and customs derived from the immutable principles of reason, and accepted by the people; and government, the particular tenor of conduct pursued by a chief and subordinate magistrate; he also asserts that the constitution of Great Britain may remain fixed for ever, that it is the basis on which her princes ought to act, and a true criterion by which their government must be appreciated; hence, according to the principles of the revolution and the present settlement, the degree of submission may be regulated, particularly as the claim of descent is remote, and the choice of the community was purposely directed to preserve the constitution.

Men in the primitive ages might live voluntarily under, or be compelled by conquest to bear a government without a constitution, but they soon (as Hooker remarks) rejected the yoke, or made it sit easy on their necks. Archdeacon Paley says, a constitution is so much of the laws of a country as mark the designation and form of its legislature, the rights and functions of the legislative body, and the nature and jurisdiction of the courts of justice, the constitution therefore is the principal section or title of the code of public laws, and the terms constitutional, and unconstitutional, signify in this case legal and illegal. The jurisprudence of England is composed of ancient usages, acts of parliament, and the decisions of the courts of law, those then are the sources whence the nature and limits of her constitution are to be deduced, and the authorities to which appeals must be made in all cases of doubt. An act of parliament can be considered unconstitutional only when it militates against other laws, which regulate the form of government. Those who consider the British constitution as a plan made by our ancestors at some distant era, are deceived, the great Charta, and the bill of Rights were successful efforts to restrain the abuses of regal power, but they are partial modifications of the constitution, which like others in Europe originated from a variety of causes, and may be compared to an old mansion repaired and altered at different periods, according to the abilities and taste of its possessors. Several approved historians conjecture that the British constitution may have had its origin from the Anglo-Saxons, those allege, that the government of the northern nations founded on the ruins of that of Rome, was free, and though injured by succeeding princes, still retains a degree of legal administration, and an air of independence. The Saxons, who conquered Britain in the fifth century, allowed their chiefs a very limited authority, and brought with them the same spirit of liberty, which had distinguished their ancestors. The king therefore depended solely on his own abilities, and possessed no arbitrary power derived from his station; the people subject to little legal restraint and less polished, paid great respect to the monarch and his family, yet were more regardless of regular descent, than present convenience, in filling the vacant throne. As their sovereignty was neither hereditary nor elective, the will of the King in the appointment of a successor was not always accepted, for the concurrence of the people was required not only in this case but in the usual mode of government: the states might establish a sovereign by suffrage, but they seldom exercised this privilege. The constitution may have differed in the different kingdoms of the Heptarchy, and have changed between the invasion and the Norman conquest, yet in all events they maintained a wittenagenot or council, whose consent was necessary for making of laws, and ratifying public acts, the preambles of all those from Ethelbert to Edward the Confessor, and even those of Canute, give undoubted proofs of the existence of a limited legal government, which was however very aristocratical, though the ancient democracy may, under the patronage of some distinguished lord have given security and dignity to the gentry, and protection to the lower classes of people. The courts of the decennary, the hundred, and the county, were well calculated to defend general liberty, and restrain the power of the nobles, and the admission of all freeholders in the latter court was a great check upon the aristocracy. Some writers assert that the government of the Anglo-Saxon princes had little more affinity to the present constitution than in the relations between the king and nobility, common to those founded by the northern nations, and place the æra of its origin at the conquest, when William of Normandy overturned the ancient form of legislation, expelled the landholders, and gave their lands to his chiefs, whose government was tyrannical, different from the constitution, and a mixture of the customs of Normandy

and the laws of Edward the Confessor, the latter he altered and confirmed in Parliament; and his statutes even declared, that all freemen should hold their possessions without unjust exaction and tollage, they rendering only their free service due to the crown; this was granted as a right by the common council of the kingdom, and has been justly called the first magna charta of the Normans, though equally conferred on the English. Notwithstanding this, the monarch often assumed absolute power, and the constitution became gradually aristocratical and oppressive to the lower orders of freemen, nor were the nobles exempt from heavy exactions on their fiefs, and he even suppressed the most powerful baronies at pleasure. Self-preservation at length suggested opposition, and the barons were induced to grant the people some advantages to secure their cooperations; as the latter soon began to feel their own importance, they ventured to make conditions for themselves, and insisted upon protection from the laws. In the reign of Henry I. the above causes produced their effects in the resolution of the nation to give the crown to a prince who should hold it under a compact with the people. Henry had sworn to grant a charter after his coronation, which he did, restoring the Saxon laws under Edward the Confessor, with the emendations made by his father and the advice of parliament, annulling evil customs, and illegal sanctions, some of those were recited in the charter, and expressly repealed; the King also mitigated his feudal rights over his own tenants; those due from theirs, and their profits, were determined by a moderate rule of law. Sir Henry Spelman was of opinion that this charter served as the basis of magna charta; those are mistaken, therefore, who consider the privileges obtained from King John as a set of innovations, as in fact they were mere restitutions of rights, and just limitations of usurped power; Lord Lyttelton even thought this charter more important than that forced from John. Henry II. granted a charter of liberties, and confirmed that of his grandfather. Through the above causes the constitution of England became the then best feudal system in the world. The same monarch established itinerant judges; and to his everlasting honour the trial by jury was extended to civil causes, which mode had been rarely used before the conquest. John having ascended the throne, ruled with the utmost despotism; in consequence a powerful confederacy extorted from him the great charter, equally favourable to the clergy, the barons, and the people. This was confirmed by Henry III. who added certain articles to prevent injustice by sheriffs, and granted charter of forests. These still remain, with little alteration, and are universally considered the safeguards of British liberty, and the basis of the constitution, justly defining the limits of power and of subjection. Edward I. declared void by his statute, called *confirmatio chartarum*, all decisions contrary to the tenor of the great charter, which was to be considered as the common law, read twice annually to the people in every cathedral, and those were to be excommunicated who infringed it; and in the statute *de tallagio non concedendo* he decreed, that no tax or impost should be levied without the joint consent of Lords and Commons. In the reign of Edward II. the Commons ventured to annex petitions to their bills granting subsidies; and in that of Edward III. they declared, they would acknowledge no law to which they refused their assent: soon after they impeached and punished certain ministers of state, and refused the granting of subsidies till their petitions to Henry IV. had been answered. In the interval from Edward I. to Henry IV. the fundamental principles of the constitution were confirmed by thirty-two statutes, those were followed by the petition of right agreed to by Charles I., the *habeas corpus* act, and other useful laws, in the reign of Charles II., and the bill of rights confirmed 1 William and Mary. The revolution of that period was the third grand æra in the history of the constitution, from which auspicious time the nature and use of government has been justly appreciated, and the false doctrine of the divine right of Kings entirely exploded: four years afterward the liberty of the press was established, and in the 12th and 13th of William and Mary, the act of settlement, limiting the crown to the present royal family, took place, which also confirms our present invaluable birth-rights, in the law, religion, and liberty.

By the combination of three species of government, monarchy, aristocracy, and democracy, in King, Lords, and Commons, the best properties of each are brought into effect, at the same time each branch operates as a check upon the encroachments of either. The principal excellence of this venerable fabric is, that every citizen may become a senator, and when such he possesses the right of proposing what laws he

pleases to the legislature; and the right of taxation belonging to the Commons, affords every reason for patiently acquiescing in their enactments, particularly as the national disbursements are annually laid before the public. The nature and degrees of punishment being fixed by laws, neither the monarch nor the magistrate can vary them, nor can a man be imprisoned falsely with impunity, through the operation of the *habeas corpus* act, or unjustly condemned when twelve impartial men of his own class decide upon his guilt or innocence. The power of framing laws vested in the two Houses of Parliament is restrained by the King's negative, and the abuse of that is prevented by their ability to refuse him supplies. In addition, all acts of the Crown are illegal without the subscription of its great officers; besides which, Parliament has the right of addressing the King, and punishing evil advisers. The appointment of obnoxious ministers may be resisted by the opposition of Parliament to their measures, and the prerogative of declaring war may be checked by the refusal of money to carry it on, and by the same means no improper use can be made of the regular army.

From this sketch of the free and enviable constitution of Great Britain we may justly infer, that no form of government ever did or can possess more inherent excellencies, and that it bears in its very nature ample means to alter and amend its few imperfections.

CONSTITUTION also denotes an ordinance, decision, regulation, or law, made by authority of any superior, ecclesiastical or civil. The constitutions of the Roman emperors make a part of the civil law, and the constitutions of the church make a part of the canon law.

CONSTITUTIONS, *apostolical*, a collection of regulations attributed to the apostles, and supposed to have been collected by St. Clement, whose name they likewise bear. It is the general opinion, however, that they are spurious, and that St. Clement had no hand in them. They appeared first in the fourth age, but have been much changed and corrupted since that time. They are divided into eight books, consisting of a great number of rules and precepts relating to the duties of christians, and particularly the ceremonies and discipline of the church. Mr. Whiston, in opposition to the general opinion, asserts them to be a part of the sacred writings, dictated by the apostles in their meetings, and wrote down from their own mouth by St. Clement, and intended as a supplement to the New Testament, or rather as a system of christian faith and polity. The reason why the constitutions are suspected by the orthodox, and, perhaps, the reason also why their genuineness is defended by Mr. Whiston, is, that they seem to favour Arianism.

CONSTRUCTION, in geometry, is the drawing such lines, such a figure, &c. as are previously necessary for the making any demonstration appear more plain and undeniable.

CONSTRUCTION *of equations*, in algebra, the method of drawing a geometrical figure whose properties shall express the given equation, in order to demonstrate the truth of it geometrically. See EQUATIONS, *construction of*.

CONSTRUCTION, in grammar, the connecting the words of a sentence according to the rules of the language. Construction is either simple or figurative, according as the parts of the discourse are placed in their natural order; or recede from that simplicity, when shorter and more elegant expressions are used than the nature affords. The construction of words, called syntax, is distinguished into two parts, concord and regimen.

CONSUL, is an officer established by virtue of a commission from the King, and other princes, in all foreign countries of any considerable trade, to facilitate and dispatch business, and protect the merchants of the nation. The consuls are to keep up a correspondence with the ministers of England residing in the courts whereon their consulate depends. They are to support the commerce and the interest of the nation; to dispose of the sums given and the presents made to the lords and principals of places, to obtain their protection, and prevent the insults of the natives on the merchants of the nation. By the treaty of Utrecht between Great Britain and Spain, the consul residing in the King of Spain's dominions shall take inventories of the estates of the English dying intestate in Spain; and these estates shall be intrusted with two or three merchants, for the security and benefit of the proprietors and creditors.

CONSULTATION, in law, a writ by which a cause being removed from the spiritual court to the King's court, is returned thither again; and the reason is, that if the judges of the King's court, by comparing the libel with the suggestion of the party, find the suggestion false or not proved, and

on that account the cause to be wrongfully called from the ecclesiastical court, then upon this consultation or deliberation they decree it to be returned. This writ is in the nature of a procedendo; yet properly a consultation ought not be granted, only in case where a person cannot recover at the common law. In causes of which the ecclesiastical and spiritual courts have jurisdiction, and they are not mixed with any temporal thing; if suggestion is made for a prohibition, a consultation shall be awarded. See PROHIBITION.

CONSUMPTION. See MEDICINE.

CONTACT, is when one line, plane, or body is made to touch another, and the parts that do thus touch are called the points or places of contact. The contact of two spherical bodies, and of a tangent with the circumference of a circle, is only in one point.

CONTACT, *angle of*, is the opening between a curve line and a tangent to it.

CONTAGION, in physic, the communicating a disease from one body to another. In some diseases it is only effected by an immediate contact, as in the syphilis; in others it is conveyed by infected clothes, and in others it seems capable of being transmitted through the air at a considerable distance. Though a very able writer in Dr. Rees's Cyclopedia produces a variety of facts to prove that the most malignant contagions are never conveyed to any great distance through the atmosphere, but that they are in fact rendered inert and harmless by diffusion in the open air, and even in the air of a well ventilated apartment. Hence the same writer, who has given an article of great interest on this subject, infers that all pestilence is propagated by near approach to, or actual contact of the diseased, or by the conveyance of the contagious poison in articles impregnated with it. This noxious matter is in many cases readily distinguished by the peculiarly disagreeable smell which it communicates to the air. No doubt this matter differs according to the diseases which it communicates, and the substance from which it has originated. Morveau lately attempted to ascertain its nature; but he soon found the chemical tests hitherto discovered altogether insufficient for that purpose. He has put it beyond a doubt, however, that the noxious matter which rises from putrid bodies is of a compound nature; and that it is destroyed altogether by certain agents, particularly by those gaseous bodies which readily part with their oxygen. He exposed air infected by putrid bodies to the action of various substances; and he judged of the result by the effect which these bodies had in destroying the fetid smell of the air. The following is the result of his experiments: odorous bodies, such as benzoin, aromatic plants, &c. have no effect whatever; neither have the solutions of myrrh, benzoin, &c. in alcohol, though agitated in infected air. Pyroligenous acid is equally inert. Gunpowder, when fired in infected air, displaces a portion of it; but what remains still retains its fetid odour. Sulphuric acid has no effect; sulphurous acid weakens the odour, but does not destroy it. Vinegar diminishes the odour, but its action is slow and incomplete. Acetic acid acts instantly, and destroys the fetid odour of infected air completely. The fumes of nitric acid, first employed by Dr. Carmichael Smith, are equally efficacious. Muriatic acid gas, first pointed out as a proper agent by Morveau himself, is equally ineffectual. But the most powerful agent is oxymuriatic acid gas, first proposed by Mr. Cruickshanks, and now employed with the greatest success in the British navy and military hospitals.

We shall observe that these gases are readily procured. Nitre, or as it is called in the new chemistry, nitrate of potash, mixed with sulphuric acid, yields a very powerful gas, the acid combining with the potash, the base of the nitre, expels the nitrous acid gas in fumes. Muriatic acid gas is obtained in a similar manner by using common salt, the alkali combines with the acid and the muriatic gas goes off in vapour. Prevention being, however, much better than the means of cure, we shall give some rules for the management of persons sick with contagious diseases. Cleanliness is essentially necessary: the chamber door should ever be kept open, and the window as much as possible in the day: the bed curtains should not be drawn, except to ward off the direct light from the window: dirty clothes, utensils, &c. should be frequently changed, and washed very clean: all discharges from the patient should be instantly removed: visitors and attendants should avoid the patient's breath, and the vapour from his body, and from all evacuations; they should never go into an infected chamber with an empty stomach, and on coming from it they should blow their nose and expectorate freely.

During the prevalence of a contagious epidemic, great care should be taken to avoid all causes of debility, and to preserve

an equal state of mind. The general alarm which prevails on such occasions contributes, not a little, to extend the evil.

CONTENT, in geometry, the area or quantity of matter or space included in certain bounds.

The content of a tun of round timber is 43 solid feet. A load of hewn timber contains 50 cubic feet: in a foot of timber are contained 1728 cubic or square inches; and as often as 1728 inches are contained in a piece of timber, be it round or square, so many feet of timber are contained in the piece. For the contents of cylindrical vessels, and vessels of other figures, see GUAGING.

CONTIGUOUS *angles*, in geometry, are such as have one leg common to each angle, and are sometimes called adjoining angles, in contradistinction to those produced by continuing their legs through the point of contact, which are called opposite or vertical angles. The sum of any two contiguous angles is always equal to two right angles.

CONTINENT, in geography, a great extent of land not interrupted by seas, in contradistinction to island, peninsula, &c.

According to what relations we have of the disposition of the globe from late navigators, we may count four continents, of which there are but two well known. The first, called the ancient continent, comprehends Europe, Asia, and Africa. The second is the new continent, called America. The third, which is called the northern or arctic continent, comprehends Greenland, the lands of Spitzberg, Nova Zembla, and the lands of Jesso. The fourth comprehends New Holland, &c.

CONTINGENT, something casual or uncertain. Hence future contingent, in logic, denotes a conditional event which may or may not happen, according as circumstances fall out.

CONTINGENT is also a term of relation for the quota that falls to any person upon a division. Thus each prince in Germany, in time of war, was formerly obliged to furnish so many men, so much money and ammunition for his contingent.

CONTINGENT *use*, in law, is an use limited in a conveyance of lands which may or may not happen to vest, according to the contingency mentioned in the limitation of the use. And a contingent remainder is when an estate is limited to take place at a time to come, on an uncertain event.

CONTINGENT *legacy*, is a legacy which may, or may not happen. If a legacy be left to one when he shall attain, or if he shall attain the age of twenty-one years, this is a contingent legacy, and if the legatee die before that time, the legacy shall not vest. But a legacy to one to be paid when he attains the age of twenty-one years, is a vested legacy; an interest which commences in *præsenti*, although it be *solvendum in futuro*: and if the legatee die before that age, his representatives shall receive it out of the testator's personal estate, at the same time that it would have become payable in case the legatee had lived.

CONTINUANCE *of a writ or action*, is its continuing in force from one term to another, where the sheriff has not returned a former writ issued out in the same action. With respect to continuances, the court of King's Bench is not to enter them on the roll till after issue or demurrer, and then they enter the continuance of all on the back, before judgment.

CONTINUED *proportion*, in arithmetic, is that where the consequent of the first ratio is the same with the antecedent of the second; as $4:8::8:16$, in contradistinction to discrete proportion.

CONTORTION, in medicine, has many significations. 1. It denotes the iliac passion. 2. An incomplete dislocation, when a bone is in part, but not entirely, forced from its articulation. 3. A dislocation of the vertebræ of the back sideways, or a crookedness of these vertebræ. And, 4. A disorder of the head, in which it is drawn towards one side, either by a spasmodic contraction of the muscles on the same side, or a palsy of the antagonist muscles on the other.

CONTORTÆ, in botany, twisted plants. The name of the thirteenth order in Linnæus's fragments of a natural method, consisting of plants which have a single petal that is twisted or bent towards one side. This order is divided into plants with twisted flowers, having five stamina and one style; and plants with twisted flowers, having five stamina and scarce any style; of the first, the genus Vinca, periwinkle, is an example; of the second, Apocynum, dog's-bane, is an example.

CONTOUR, in painting, the out-line, or that which defines a figure.

CONTRABAND, in commerce, a prohibited commodity, or merchandise bought or sold, imported or exported, in prejudice to the laws and ordinances of a state, or

the public prohibitions of the sovereign. Contraband goods are not only liable to confiscation themselves, but also subject all other allowed merchandise found with them in the same box, bale or parcel, together with the horses, waggons, &c. which conduct them. There are contrabands likewise, which, besides the forfeiture of the goods, are attended with several penalties and disabilities.

In this country, there are two principal contrabands for exportation, wools and live sheep, which all strangers are prohibited from carrying out of the country; the other that of sheep skins and calf skins. See CUSTOMS.

CONTRACT, in a general sense, a mutual consent of two or more parties, who voluntarily promise and oblige themselves to do something, pay a certain sum, or the like. All donations, exchanges, leases, &c. are so many different contracts.

CONTRACT, in common law, an agreement or bargain between two or more persons, with a legal consideration or cause; as where a person sells goods, &c. to another for a sum of money; or covenants, in consideration of a certain sum, or an annual rent, to grant a lease of a messuage, &c. Contracts are two-fold, either express or implied. Express contracts are where the terms of the agreement are openly uttered, as, to pay a stated price for certain goods. Implied, are such as reason and justice dictate, and which, therefore, the law presumes that every man undertakes to perform: thus, if a man take up wares from a tradesman, without any agreement of price, the law concludes that he contracted to pay their real value.

CONTRACT *usurious*, is an agreement to pay more interest for money than the laws allow.

CONTRACTION, in physics, the diminishing the extent or dimensions of a body, or the causing its parts to approach nearer to each other, in which sense it stands opposed to dilatation or expansion. See EXPANSION.

Water and all aqueous fluids are gradually contracted by a diminution of temperature, until they arrive at a certain point, which is about 8° above the freezing point; but below that point they begin to expand, and continue to do so according as the temperature is lowered. Similar effects have been observed with regard to some metals. Speaking of contraction, a remarkable phenomenon, of considerable importance in manufactures, obtrudes itself on our notice. It is the hardness which certain bodies acquire in consequence of a sudden contraction, and this is particularly the case with glass and some of the metals. Thus glass vessels, suddenly cooled after having been formed, are so very brittle, that they hardly bear to be touched with any hard body. The cause of this effect is thus properly explained by Dr. Young. "When glass in fusion is very suddenly cooled, its external parts become solid first, and determine the magnitude of the whole piece, while it still remains fluid within. The internal part, as it cools, is disposed to contract still further, but its contraction is prevented by the resistance of the external parts, which form an arch or vault round it, so that the whole is left in a state of constraint; and as soon as the equilibrium is disturbed in any one part, the whole aggregate is destroyed. Hence it becomes necessary to anneal all glass, by placing it in an oven, where it is left to cool slowly; for, without this precaution, a very slight cause would destroy it. The Bologna jars, sometimes called proofs, are small thick vessels made for the purpose of exhibiting this effect; they are usually destroyed by the impulse of a small and sharp body; for instance, a single grain of sand, dropped into them, and a small body appears to be often more effectual than a larger one; perhaps because the larger one is more liable to strike the glass with an obtuse part of its surface."

CONTRA *harmonical proportion*, in arithmetic, is that relation of three terms, wherein the difference of the first and second is to the difference of the second and third as the third is to the first: thus, 3, 5, and 6, are numbers contra-harmonically proportional, for $2 : 1 :: 6 : 3$.

CONTRAST, in architecture, is to avoid the repetition of the same thing, in order to please by variety.

CONTRATE *wheel*, in watch-work, that next to the crown, the teeth and hoop whereof lie contrary to those of the other wheels, from whence it takes its name.

CONTRAVALLATION, or *the line of contravallation*, in fortification, a trench guarded with a parapet, and usually cut round about a place by the besiegers, to secure themselves on that side, and to stop the sallies of the garrison. See FORTIFICATION.

CONTRAVENTION, in law, a man's failing to discharge his word, obligation,

duty, or the laws or customs of the place. The penalties imposed in cases of contravention only pass for comminatory.

CONTRAVENTION, in a more limited sense, signifies the non-execution of an ordinance or edict. It is supposed to be the effect of negligence or ignorance.

CONTRAYERVA. See MATERIA MEDICA.

CONTRE, in heraldry, an appellation given to several bearings, on account of their cutting the shield contrary and opposite ways: thus we meet with contre-bend, contre-chevron, contre-pale, &c. when there are two ordinaries of the same nature opposite to each other, so as colour may be opposed to metal, and metal to colour.

CONTRIBUTION, in a general sense, the payment of each person's quota, or the share he bears in some imposition or common expense. Contributions are either voluntary, as those of expenses for carrying on some undertaking for the public interest; or involuntary, as those of taxes and imposts.

CONTRIBUTION, in a military sense, an imposition or tax paid by frontier countries to an enemy, to prevent their being plundered and ruined by him.

CONTROLLER, an officer appointed to control or oversee the accounts of other officers, and, on occasion, to certify whether or no things have been controlled or examined. In England we have several officers of this name, controller of the King's house, controller of the navy, controller of the customs, controller of the mint, &c.

CONTROLLER *of the hanaper*, an officer that attends the Lord Chancellor daily, in term and in seal-time, to take all things, sealed in leather bags, from the clerks of the hanaper, and to mark the number and effect thereof, and enter them in a book, with all the duties belonging to the King and other officers, for the same, and so charge the clerk of the hanaper with them.

CONTROLLER *of the pipe*, an officer of the Exchequer, that makes out a summons twice every year, to levy the farms and debts of the pipe.

CONTROLLERS *of the pells*, two officers of the Exchequer, who are the Chamberlain's clerks, and keep a control of the pell of receipts, and goings out.

CONTUMACY, in law, a refusal to appear in court, when legally summoned; or the disobedience to the rules and orders of a court, having power to punish such offence.

CONTUSION. See MEDICINE and SURGERY.

CONVALLARIA, in botany, *lily of the valley*, a genus of the Hexandria Monogynia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: corolla six-cleft; berry spotted, three-celled. There are eleven species, of which C. maialis, sweet-scented lily of the valley, has a perennial root, with numerous fibres transversely wrinkled, creeping horizontally, just below the surface, to a considerable distance. The whole plant is smooth, the base of the leaves and stalk are bound together, with four or five alternate purplish scales; flowers from six to eight, in a raceme, nodding; white and fragrant peduncles, bending, one-flowered, round filiform, corolla contracted at the mouth. Native of Europe, from Lapland to Italy. The lily of the valley claims our notice as an ornamental plant; few are held in greater estimation; indeed few flowers can boast such delicacy with so much fragrance. When dried they have a narcotic scent, and if reduced to powder excite sneezing.

CONVENTICLE, a private assembly or meeting, for the exercise of religion. The word was first attributed as an appellation of reproach to the religious assemblies of Wickliffe in this nation, in the reigns of Edward III. and Richard II. and is now applied to illegal meetings of non-conformists. There were several statutes made in former reigns, for the suppression of conventicles; but by 1 Will. and Mary, it is ordered, that dissenters may assemble for the performance of religious worship, provided their doors be not locked, barred, or bolted. Conventicle, in strict propriety, denotes an unlawful assembly, and cannot, therefore, be justly applied to the legal assembling of persons in places of worship certified, or licensed, according to the requisitions of law.

CONVENTION, a treaty, contract, or agreement between two or more parties. Every convention among men, provided it be not contrary to honesty and good manners, produces a natural obligation, and makes the performance a point of conscience. Every convention has either a name and a cause of consideration, or it has none; in the first case it obliges civilly and naturally, in the latter only naturally.

CONVENTION is also a name given to an extraordinary assembly of parliament, or the states of the realm, held without the

King's writ; as was the convention of estates, who, upon the retreat of James II. came to a conclusion that he had abdicated the throne, and that the right of succession devolved to King William and Queen Mary; whereupon their assembly expired as a convention, and was converted into a parliament.

CONVERGING, or CONVERGENT *lines*, in geometry, are such as continually approach nearer one another; or whose distance becomes still less and less. These are opposed to divergent lines, the distance of which become continually greater: those lines which converge one way diverge the other.

CONVERGING *hyperbola*, is one whose concave legs bend in towards one another, and run both the same way.

CONVERGING *rays*, in optics, those rays that, issuing from divers points of an object, incline towards one another, till, at last, they meet and cross, and then become diverging rays. See OPTICS.

CONVERGING *series*. See SERIES.

CONVERSE, in mathematics. One proposition is called the converse of another, when, after a conclusion is drawn from something supposed in the converse proposition, that conclusion is supposed; and then, that which in the other was supposed, is now drawn as a conclusion from it: thus, when two sides of a triangle are equal, the angles under these sides are equal; and, on the converse, if these angles are equal, the two sides are equal.

CONVERSION *of equations*, in algebra, is when the quantity sought, or any part or degree thereof, being in fractions, the whole is reduced to one common denomination, and then omitting the denominators, the equation is continued in the numerators only. Thus suppose $a - b = \frac{aa + cc}{d} + h + b$; multiply all by d, and it will stand thus, $da - db = aa + cc + dh + db$.

CONVEX, an appellation given to the exterior surface of gibbous or globular bodies, in opposition to the hollow inner surface of such bodies, which is called concave: thus we say a convex lens, mirror, superficies, &c.

CONVEXITY, that configuration or shape of a body, on account of which it is denominated convex.

CONVEYANCE, in law, a deed or instrument that passes land, &c. from one person to another. The most common conveyance now in use are, deeds of gifts, bargain and sale, lease and release, fines and recoveries, settlements to uses, &c. A conveyance cannot be fraudulent in part, and good as to the rest; for if it be fraudulent and void in part, it is void in all, and it cannot be divided. Fraudulent conveyances to deceive creditors, defraud purchasers, &c. are void by stat. 50 Edw. III. c. 6. 13 Eliz. c. 5—27. Eliz. c. 4.

CONVICT, in common law, a person that is found guilty of an offence by the verdict of a jury. The law implies that there must be a conviction before punishment for any offence, though it be not mentioned in any statute. On a joint indictment, or information, some of the defendants may be convicted and others acquitted.

CONVICT *recusant*, a person who has been legally presented, indicted, and convicted, for refusing to come to church to hear the common prayer, according to the statutes 1 and 23 Eliz. and 3 Jac. I.

CONVOCATION, an assembly of the clergy of England, by their representatives, to consult of ecclesiastical matters. It is held during the session of parliament, and consists of an upper and a lower house. In the upper sit the bishops, and in the lower the inferior clergy, who are represented by their proctors, consisting of all the deans and archdeacons, of one proctor for every chapter, and two for the clergy of every diocese, in all one hundred and forty-three divines, *viz.* twenty-two deans, fifty-three archdeacons, twenty-four prebendaries, and forty-four proctors of the diocesan clergy. The lower house chooses its prolocutor, whose business it is to take care that the members attend, to collect their debates and votes, and to carry their resolutions to the upper house. The convocation is summoned by the King's writ, directed to the archbishop of each province, requiring him to summon all bishops, deans, archdeacons, &c.

The power of the convocation is limited by a statute of Henry VIII. They are not to make any canons or ecclesiastical laws without the King's licence; nor when permitted to make any, can they put them in execution but under several restrictions. They have the examining and censuring all heretical and schismatical books and persons, &c. but there lies an appeal to the King in chancery, or to his delegates. The clergy in convocation, and their servants, have the same privileges as members of parliament. See PARLIAMENT.

CONVOLVULUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ, or bell-form flowers. Convolvuli, Jussieu. Essential character: corolla bell-shaped, plaited; stigmas two; capsules two-celled, with two seeds in each cell. There are 110 species of this very numerous genus, not more than thirteen species are natives of Europe; the others are mostly inhabitants of the warmer climates of Asia and America. Very few of them are cultivated in our gardens, except C. purpureus, purple bindweed; and C. tricolor, trailing bindweed, more commonly known by the names of convolvulus, major, and minor; the stems are herbaceous and milky, in the greater part twining, in a very few shrubby; leaves alternate; peduncles axillary or terminating, one flowered, with two bractes, or many flowered.

CONVOY, in marine affairs, one or more ships of war, employed to accompany and protect merchant-ships, and prevent their being insulted by pirates, or the enemies of the state in time of war.

CONVOY, in military matters, a body of men that guard any supply of men, money, ammunition, or provisions, conveyed by land into a town, army, or the like, in time of war.

CONVULSION. See MEDICINE.

CONUS, in natural history, a genus of Vermes Testacea: animal a limax; shell univalve, convolute, turbinate; aperture effuse, longitudinal, linear, without teeth, entire at the base; pillar smooth. This genus is divided into five distinct families, *viz.* A. spire or turban nearly truncate. B. pyriform with a rounded base; the cylinder half as long again as the spire. C. elongated and rounded at the base; the cylinder as long again as the spire. D. ventricose in the middle, and contracted at each end. E. thin, ventricose, and making a tinkling sound when thrown on its back upon a table or board. There are upwards of 70 species enumerated. Many of the conus tribe are beautiful shells, and bear a high price on account of their rarity. We have no species of this genus upon the English coast. Some very curious kinds have been discovered in a fossil state in England, chiefly in the chalk cliffs of Hampshire.

CONYZA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, roundish; corolla of the ray three-cleft; down simple; recepticle naked. There are forty-three species. The Conyzas or Fleabanes are either herbaceous or shrubby; in a few of them the leaves are decurrent; the flowers are of the compound kind without any ray, in corymbs or panicles at the top of the stem and branches.

COOKIÆ, in botany, a genus of the Decandria Monogynia class and order. Calyx five-cleft, inferior; corolla five-petalled, equal inferior; pome five-celled; the cells one seeded. One species found in China.

COOKERY, or *cooking*, the exercise of art in the preparation of food for human sustenance. It consists not only in the application of heat under various modifications and circumstances, but also in the due intermixture of condiments, calculated as well to please the palate as to promote nutrition. The exercise of this art is peculiar to man, and it has been deemed by naturalists one of his peculiar characteristics, that he is "a cooking animal." Dr. Cullen says, that the cooking of vegetables by boiling renders them more soluble in the stomach, notwithstanding the degree of coagulation which their juices undergo. In the second place, the application of a boiling heat dissipates the volatile parts of vegetable substances, which are seldom of a nutritious nature, but, in many cases, have a tendency to prove noxious. In the third place, boiling, helps to extricate a considerable quantity of air that, in the natural state of vegetables, is always fixed in their substance; and it is probably in this way especially, that heat contributes to the dividing and loosening the cohesion of their smaller parts. Thus they are rendered less liable to ferment, and to produce that flatulence which is so troublesome to weak stomachs.

In the cookery of animal substances, some practices, previous to the application of heat, are to be considered as affecting their solubility in the stomach; particularly salting and pickling. These processes are spoken of under the article CONDIMENTS.

The cookery of animal substances is of two kinds, as it is applied in a humid form in boiling and stewing; or in a dry form, in roasting, broiling, and baking. By the joint application of heat and moisture to meat in boiling, the texture is certainly rendered more tender and more soluble in the stomach; and it is only in this way that the

firmer parts, as the tendinous, ligamentous, and membranous parts, can be duly softened, and their gelatinous substance rendered subservient to nutrition. Yet these effects are different according to the degree of boiling. A moderate boiling may render their texture more tender without much diminution of their nutritious quality; but if the boiling is extended to extract every thing soluble, the substance remaining is certainly less soluble in the stomach, and at the same time much less nutritious. But as boiling extracts, in the first place, the more soluble, and therefore the saline parts; so what remains is, in proportion, less alkalescent, and less heating to the system.

Boiling in digesters, or vessels accurately closed, produces effects very different from boiling in open vessels. From meat cooked in the latter, there is no exhalation of volatile parts; the solution is made with great success, and if not carried very far, the meat may be rendered very tender, while it still retains its most sapid parts; and this is esteemed always the most desirable state of boiled meat. If a small quantity of water only is applied, and the heat continued long in a moderate degree, the process is called stewing, which has the effect of rendering the texture of meat more tender, without extracting much of the soluble parts. This, therefore, leaves the meat more sapid, and in a state perhaps the most nourishing of any form of cookery; as we learn from the admirable essays and experiments of Count Rumford, who found very unusual effects produced on meat, by a low degree and long-continued action of heat, both in the dry and humid way.

The application of a dry heat in the cookery of meat is of two kinds, as it is carried on in close vessels, or as it is exposed to the air. The first of these which we shall consider is baking. In this practice meat has generally a covering of paste, by which any considerable exhalation is prevented, and the retention of the juices renders the meat more tender. In all cases, when the heat applied loosens, and in some measure extricates the air, without exhaling it, the substance submitted to this process is rendered more tender than when an exhalation is allowed. In broiling, an exhalation takes place; but as the heat of a naked fire is more nearly applied, the outer surface is in some measure hardened before the heat penetrates the whole, and thereby a great exhalation is prevented, while the whole is rendered sufficiently tender; but this kind of cookery is suited to meats that are chosen to be eaten a little raw. Nearly a-kin to this is the practice of frying, in which the meat being cut into thin slices, and laid in a pan over the naked fire, the heat is applied more equally to the whole substance. But as the part of the meat lying next to the bottom of the vessel would be suddenly hardened by the heat, it is always necessary to interpose some fluid matter, usually of an oily quality, as butter. A strong heat applied to the latter renders it empyreumatic, or at least less miscible with the fluids of the stomach: so that all fried meats are less easily digested than those of any other preparation. Sometimes, indeed, the same thing happens to baked meats, to which an oily matter, and that only, is added to avoid the too drying heat of the oven. It is obvious that the preparations of stewing and frying may be frequently joined together; and according to there being more or less of the one or other, the effects may be imagined.

COOLER, among brewers, distillers, &c. a large vessel wherein certain liquors are cooled after having been boiled.

COOMB, or COMB *of corn*, a dry measure, containing four bushels, or half a quarter.

COOPER, in the trades, an artificer who makes casks, tubs, barrels, and all kinds of wooden vessels which are bound together with hoops. This is unquestionably a very ancient trade, and is referred to 2000 years ago by the writers on rural economy in Rome. Their descriptions correspond in a good measure with the construction of casks in our day. It is not known when the business of a cooper was first introduced into this country, but it has been supposed it was derived from the French. Wood used for the purpose of cask-making, should be old and thick, strait trees are the best, from these are hewn thin planks, which are formed into staves. In France, we are told, the wood is prepared in winter; the staves and bottoms are then formed, and they are put together in summer. Planing the staves is one of the most difficult parts of the work, and it is at the same time one of the most important in the fabrication of casks. In the formation of the staves, it must be recollected that each is to constitute part of a double conoid. Each stave must therefore be broader at the middle, and gradually become narrower, but not in straight lines towards the

extremities. The outside of the staves, across the wood, must be wrought into the segment of a circle; and it must be thickest near the middle, growing gradually thinner towards the ends. After the staves are dressed and ready to be arranged, the cooper without attempting any great nicety in sloping them, so that the whole surface of the edge may touch in every point, brings the contiguous staves into contact only at the inner surface; and in this way, by driving the hoops hard, he can make a closer joint than could be done by sloping them from the outer to the inner side.

Cooper, on board a ship, he that looks to the casks and all other vessels for beer, water, or any other liquor. He has a mate under him.

COPAIFERA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Leguminosæ, Jussieu. Essential character: calyx none; petals five; legume ovate; seed one, with a berried aril. There is but one species, *viz.* C. officinalis, balsam of capevi tree. This is a lofty elegant tree, with a handsome head, the extreme branches at the axils are flexuose, with a brownish ash-coloured bark; leaves alternate, round, four inches long; racemes axillary, solitary, loosely divided into eight alternate, lateral common peduncles, an inch and half in length, with white flowers sitting closely on them. Native of South America, from this tree is obtained in very considerable quantities, by perforating the trunk, fluid balsam or resin, which thickens by degrees; and which is known in medicine by the title of balsam of copaiva. See Balsam.

COPAL. This substance which deserves particular attention from its importance as a varnish, and which at first sight seems to belong to a distinct class from the resins, is obtained from the rhus copallinum, a tree which is a native of North America; but the best sort of copal is said to come from Spanish America, and to be the produce of different trees.

Copal is a beautiful white resinous substance, with a slight tint of brown. It is sometimes opaque, and sometimes almost perfectly transparent. When heated it melts like other resins; but it differs from them in not being soluble in alcohol, nor in oil of turpentine without peculiar management. Neither does it dissolve in the fixed oils with the same ease as the other resins. It resembles gum animé a little in appearance, but is easily distinguished by the solubility of this last in alcohol, and by its being brittle between the teeth, whereas animé softens in the mouth. The specific gravity of copal varies from 1.045 to 1.139. Mr. Hatchett found it soluble in alkalies and nitric acid with the usual phenomena, so that in this respect it agrees with the other resins.

When copal is dissolved in any volatile liquid, and spread thin upon wood, metal, paper, &c. so that the volatile menstruum may evaporate, the copal remains perfectly transparent, and forms one of the most beautiful and perfect varnishes that can well be conceived. The varnish thus formed is called copal varnish, from the chief ingredient in it. Copal varnish used by the English japanners is made as follows. Four parts by weight of copal in powder are put into a glass matrass and melted. The liquid is kept boiling till the fumes, condensed upon the point of a tube thrust into the matrass, drop to the bottom of the liquid without occasioning any hissing noise as water does. This is a proof that all the water is dissipated, and the copal has been long enough melted. One part of boiling hot linseed oil (previously boiled in a retort without any litharge) is now poured into it, and well mixed. The matrass is then taken off the fire, and the liquid, while still hot, is mixed with about its own weight of oil of turpentine. The varnish thus made is transparent, but it has a tint of yellow, which the japanners endeavour to conceal by giving the white ground on which they apply it a shade of blue. It is with this varnish that the dial plates of clocks are covered after having been painted white.

Mr. Sheldrake has lately favoured the public with another and easier method of dissolving copal. This method is as follows: "Provide a strong vessel made of tin or other metal; it should be shaped like a wine bottle, and capable of holding two quarts; it will be convenient to have a handle strongly rivetted to the neck; the neck should be long and have a cork fitted to the mouth, but a notch or small hole should be made in the cork, that, when the spirit is expanded by heat, a small portion may force its way through the hole, and thus prevent the vessel from bursting. Dissolve half an ounce of camphor in a quart of spirit of turpentine, and put it into the vessel; take a piece of copal the size of a large walnut, reduce it to a coarse powder or very small pieces, put them into the tin bottle, fasten the cork down with a wire,

and set it, as quick as possible, upon a fire so brisk as to make the spirit boil almost immediately; then keep it boiling very gently for about an hour, when so much of the copal will be dissolved as will make a very good varnish; or, if the operation has been properly begun, but enough of copal has not been dissolved, it may be again put on the fire, and by boiling it slowly for a longer time, it may be at last brought to the consistence desired.

COPARCENARY, an estate held in coparcenary, is where lands of inheritance descend from the ancestor to two or more persons. It arises either by common law, or particular custom. By common law, as where a person seised in fee-simple, or fee-tail dies, and his next heirs are two or more females, his daughters, sisters, aunts, cousins, or their representatives; in this case they shall all inherit. And these co-heirs are then called coparceners; or for brevity sake parceners. Parceners, by particular custom, are where lands descend, as in gavel-kind, to all the males in equal degree, as sons, brothers, uncles, or other kindred; and in either of these cases, all the parceners put together make but one heir, and have but one estate among them.

COPERNICAN-*system*, or Hypothesis, that system of the world, wherein the Sun is supposed at rest in the centre, and the planets, with the Earth, to move in ellipses round him. The Sun and stars are here supposed at rest, and that diurnal motion which they appear to have from east to west, is imputed to the Earth's motion from west to east, round its axis. This system was received of old by Philolaus, Aristarchus, and Pythagoras, from which last it had the name of the Pythagoric system: it was also held by Archimedes; but after him it became neglected, and even forgotten for many ages, till it was revived by Copernicus, about the year 1500, and from him named the Copernican system. According to this hypothesis, the Sun is supposed very nearly the centre of gravity of the whole system, and in the common focus of every one of the planetary orbits: next to him Mercury performs his revolution around him; next Mercury is the orbit of Venus; then the Earth, with its attendant or secondary the Moon, performing a joint course, and in their revolution measuring out the annual period. Next the Earth is Mars, the first of the superior planets; next him Jupiter, then Saturn, and, lastly, the Herschel planet. Between Mars and Jupiter, have been discovered four very small bodies, called ASTEROIDES, which see.

These and the comets are the constituent parts of the solar system, which is now received and approved as the only true one See ASTRONOMY.

COPERNICUS (NICHOLAS) in biography, was born at Thorn, in Prussia, in 1472. Having acquired during the course of his education at Cracow a fondness for mathematical studies, and particularly for astronomy, he went to Bologna, to prosecute these studies under an eminent astronomer of that university. Here he obtained such distinction, that he was appointed professor of mathematics at Rome. Returning after some years to his native country, he obtained a canonry in the cathedral church of Frauenburg, and in the leisure which this situation afforded him pursued his astronomical speculations. Perceiving the Ptolemaic system (which supposes the Earth to be fixed in the centre, and the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, to revolve about it in concentric circles) to be inconsistent with the phenomena, and encumbered with many absurdities, he had recourse to the Pythagorean hypothesis, which places the Sun in the centre of the system, and makes the Earth a planet, revolving annually with the rest about the Sun, and daily about its own axis. Upon this system, compared with the observations which had been made by others and himself, he proceeded to ascertain the periodical revolutions of the planets, and wrote his treatise, "De Orbium Cœlestium Revolutionibus"—"On the Revolutions of the Heavenly Bodies," in which he demonstrated them geometrically.

A doctrine which explained the celestial phenomena with so much simplicity could not fail to engage the attention and admiration of astronomers and philosophers. But, on account of its inconsistency with some passages of scripture, it was rejected by many divines, and censured in an express decree of the Romish church. Nevertheless the doctrine daily gained ground, and is now universally received. Copernicus died in 1543.

COPPEL, COPEL, or CUPPEL, a chemical vessel made of earth, pretty thick, and of the form of a platter or dish. See LABORATORY.

COPPER, in the arts, seems to have been known in the remotest periods of antiquity. It is among the first metals which was employed by the early nations of the world; it is not one of the scarce metals, is easily

extracted from its ores, and not difficult to work. The Egyptians applied it to a great variety of uses, as it appears from the earliest period of their history. The Greeks were acquainted with the mode of working copper, and employed it in many of the arts. It was the basis of the celebrated Corinthian metal. The Romans knew the uses of this metal, and it is generally supposed that of it they fabricated the greatest number of their utensils. The alloys which they made with copper, after the example of the Egyptians and Greeks, were very numerous, and applied to a great variety of uses. Copper exists in considerable abundance in nature; it is found native, alloyed with other metals, combined with sulphur, in the state of oxide, and in that of salt. It is not unfrequently met with in the native state, sometimes crystallized in an arborescent form, and sometimes in more regular figures. Copper exists native, alloyed with gold and silver. The most abundant ores of copper are the sulphurets, and of these there is a considerable variety, exhibiting various colours and various forms of crystals. In the state of oxide, it has been found in Peru, of a greenish colour, mixed with white sand. In the state of salt, copper is combined with the sulphuric and carbonic acids, forming native sulphates and carbonates of copper. The latter present many varieties, but may chiefly be referred to the blue and green carbonates. The extraction of the ores of copper is to be conducted according to the nature of the combination in which they exist. The following process is recommended for the treatment of the sulphurets of copper. The ore is first reduced to powder, and then boiled with five parts of concentrated sulphuric acid. The solution is evaporated to dryness, and the residuum well washed with warm water, to remove all soluble matters. The solution being sufficiently diluted, a plate of copper is immersed in it, which precipitates the silver, and afterwards a plate of iron to precipitate the copper. It is boiled with the plate of iron till no farther precipitate takes place. The copper which is thus obtained is dried with a gentle heat, so that it may not undergo oxidation. It is supposed that the copper is mixed with iron; the whole may be dissolved in nitric acid; and the process is again repeated by introducing the plate of iron. In this way it is easy to discover the quantity of copper in the sulphurets of this metal.

Copper is a very brilliant metal, of a fine red colour, differing from every other metallic substance. The specific gravity of copper is 8.58. When it is hammered it acquires a greater density. It possesses a considerable degree of hardness, and some elasticity. It is extremely malleable, and may be reduced to leaves so fine, that they may be carried about by the wind. It has also a considerable degree of ductility, intermediate, according to Guyton, between tin and lead. The tenacity of copper is also very great. A wire .078 of an inch in diameter will support a weight without breaking equal to more than 300 *lbs.* avoirdupois. Copper has a peculiarly astringent and disagreeable taste. It is extremely deleterious, when taken internally, to the animal economy, and indeed may be considered as a poison. It is distinguished by a peculiarly disagreeable odour, which it communicates to the hands by the slightest friction. Copper does not melt till the temperature is elevated to a red heat, which is about 27° Wedgwood, or by estimation 1450° Fahrenheit. When it is rapidly cooled after fusion, it assumes a granulated and porous texture; but if it be cooled slowly, it affords crystals in quadrangular pyramids, or in octahedrons, which proceed from the cube, its primitive form. When the temperature is raised beyond what is necessary for its fusion, it is sublimed in the form of visible fumes. When copper is exposed to the air, especially if it be humid, it is soon deprived of its lustre. It tarnishes, becomes of a dull brown colour, which gradually deepens till it is converted into that of the antique bronze, and at last is covered with a shining green crust, which is well known under the name of verdigris. This process is the oxidation of the metal by the absorption of oxygen from the atmosphere; and it is promoted and accelerated, either by being moistened with water, or by the water which exists in the atmosphere. As this oxide is formed, the carbonic acid of the atmosphere combines with it, so that it is to be considered as a mixture of oxide and carbonate of copper. But when copper is subjected to a strong heat, the oxidation proceeds more rapidly. If a plate of copper be made red-hot in the open air, it loses its brilliancy, becomes of a deep brown colour, and the external layer, which is of this colour, may be detached from the metal. This is the brown oxide of a copper. This oxide may be obtained by immersing a plate of red-hot copper into cold water. The scales which are formed on the surface

fall off by the sudden contraction of the heated copper. This may be repeated till the whole is converted into this oxide. The copper in this state is in the highest degree of oxidation. The component parts of this oxide are,

Oxygen.............	25
Copper.............	75
	100

There are, however, different oxides; copper combines with a smaller proportion of oxygen, forming an oxide of an orange colour. This is the oxide of copper with the smaller proportion of oxygen. The component parts of this oxide, according to Mr. Chenevix, are,

Oxygen...........	11.5
Copper...........	88.5
	100.0

This oxide changes colour the moment it is exposed to the air, by the absorption of oxygen, for which it has a very strong affinity. There is no action between azote, hydrogen, or carbon, and copper. Phosphorus readily combines with copper, and forms with it a phosphuret, which is prepared by fusing equal parts of copper and phosphoric gas, with $\frac{1}{8}$th of the whole of charcoal in powder. Copper combines with sulphur by different processes. If sulphur in powder and filings of copper are mixed together, and formed into a paste with a little water, when they are exposed to the air, the mass swells up, becomes hot, and is converted into a brown matter, which effloresces slowly in the air, and is converted into sulphate of copper.

Copper combined with sulphur is one of the most common ores of this metal. According to the experiments of Proust, the natural production, known by the name of copper pyrites, is a sulphuret of copper, combined with an additional portion of sulphur. It is distinguished by its brittleness, metallic lustre, and yellow colour.

The alloys of copper (that is, those in which this metal predominates) are more numerous and more important in the arts than those of any other metal. Many of them are perfectly well known, and have been in use from very ancient times; of many the exact composition, and particularly the mode of preparing, are kept as secret as possible; for even when the precise composition of an alloy is found by chemical analysis, it may often be extremely difficult to produce a mixture by common methods, which shall have exactly the same shade of colour, the same malleability, texture, susceptibility of polish, or some other excellence, which, perhaps, a mere accident has discovered to the possessor.

The principal objects of alloying copper appears to be to render it less liable to tarnish, and especially to be acted on by common animal or vegetable substances, to make it more fusible, and harder, and able to take a higher polish, and to alter its colour either to a golden yellow or silvery white. All these objects are attainable by different alloys. Copper alloyed with gold, silver, and platina, is seldom, if ever, used in the proportions in which it would be reckoned as alloy of copper, being much too costly for any purpose of manufacture; with this exception, however, that a very small portion of silver much improves the composition of the alloy of copper and tin, when used as bell-metal or speculum-metal. Copper is used largely as an alloy of gold and silver, and it is often plated with one or the other.

Tutenag is a white alloy of copper, zinc, and iron, according to Keir, which is very hard, tough, and sufficiently ductile to be wrought into various articles of furniture, such as candlesticks, &c. which take a high polish, and when made of the better sort of tutenag are hardly distinguishable from silver. The inferior kinds are still white, but with a brassy yellow. The Chinese petong is another fine, white, malleable alloy of copper, the composition of which is not exactly known, but it contains a small portion of silver. Copper unites with lead very intimately by fusion, but when a mass of this alloy is exposed to a heat less than that at which the whole melts, the lead alone sweats out, leaving almost all the copper in a porous or honey-combed state. When the copper holds a small portion of silver, the lead carries the latter out with it, and this is the principle of the old process of eliquation, formerly much used in the extracting of silver from copper ores. Copper, with about a fourth of its weight of lead, forms pot-metal, used by the ancients for their coins.

Copper nearly saturated with zinc, forms brass, the most important of all the alloys of this metal. See Brass. With a much less proportion of zinc the colour of the alloy approaches very nearly to that of gold, and the malleability increases. Mixtures chiefly of these two metals are used to form

a variety of yellow or gold-coloured alloys, known by the names of tombac, Manheim, or Dutch gold, tinsel, similor, Prince Rupert's metal, Pinchbeck, &c.; but the precise composition varies according to the fancy or the experience of different manufacturers. The Dutch gold may be beaten out into extremely fine leaves, which, when fresh, have nearly the brilliance of gold-leaf, and are used as a cheap imitation of it; but they tarnish very soon. The mixture may be made, either by directly melting copper and zinc, or by mixing brass and copper. In either case the copper should be melted first, and the zinc added afterwards, the whole stirred together with wood, covering it with a little charcoal, and poured out immediately, to prevent the loss by the burning off the zinc. A kind of tombac is the material of which a large proportion of the Roman coins was composed. Klaproth on analyzing several struck during the first century of the emperors, found them all to consist either of pure copper, or of copper and zinc, in which the latter metal made generally from a fifth to a sixth of the mass. A little tin and lead were found in some; but in such small proportion as to appear only an accidental impurity.

The alloys of copper and tin are extremely important in the arts, and curious as chemical mixtures. They form, in different proportions, mixtures which have a distinct and appropriate use. Tin added to copper makes it more fusible; much less liable to rust or corrosion by common substances; harder, denser, and more sonorous. In these respects the alloy has a real advantage over unmixed copper; but this is in many cases more than counterbalanced by the extreme brittleness which even a moderate portion of tin imparts, and which is a singular circumstance, considering how very malleable both metals are before mixture, and the remarkable softness and ductility of tin.

Copper, or sometimes copper with a little zinc, alloyed with as much tin as will make from about $\frac{1}{10}$th to about $\frac{1}{5}$th of the whole, forms an alloy which is the principal, and often the only composition for bells, brass cannon (so called), bronze statues, and several smaller purposes, and hence it is called bronze, or bell-metal; and it is excellently fitted for these purposes, by its hardness, density, sonorousness, and fusibility, whereby the minute parts of hollow moulds may be readily filled before it fixes in cooling. For cannon a lower portion of tin seems to be used. Bronze cannon are much less liable to rust than those of iron; but in large pieces of ordnance, by very rapid firing, the touch-hole is apt to melt down, and spoil the piece; of which there is a remarkable instance at the Tower of London, of a mortar of the largest calibre thus spoiled at the siege of Namur. On account of the sonorousness of bronze, these cannon give a much sharper report than those of iron, which for a time impairs the hearing of the people that work them. A common alloy for bell-metal is about 80 of copper to 20 of tin; or where copper, brass, and tin are used, the copper is from 70 to 80 per cent. including the portion contained in the brass, and the remainder is tin and zinc. The zinc certainly makes it more sonorous. Antimony is also often found in small quantity in bell-metal. Some of the finer kinds used for small articles contain also a little silver, which much improves the sound. When the tin is nearly one-third of the alloy, it is then most beautifully white, with a lustre almost like that of mercury, extremely hard, very close-grained, and perfectly brittle. In this state it takes a most beautiful polish, and is admirably fitted for the reflection of light for all optical purposes. It is then called speculum metal, which, however, for the extreme perfection required in modern astronomical instruments, is better mixed with a very small proportion of other metals, particularly arsenic, brass, and silver.

When more tin is added than amounts to half the weight of the copper, the alloy begins to lose that splendid whiteness for which it is so valuable as a mirror, and becomes more of a blue-grey. As the tin increases, the texture becomes rough-grained, and as it were rotten, and totally unfit for manufacture. The speculum metal is therefore in the highest proportion of alloy of tin that copper will admit, for any useful purpose. See Aikin's Dictionary of Chemistry.

COPPERAS is the sulphate of iron, and is commonly called green vitriol. If sulphuric acid be diluted with water, and be poured upon iron, much effervescence will be seen: the metal will be dissolved, and the solution, when evaporated, will exhibit the sulphate of iron, or common copperas, which is a neutral salt in a very impure state. Copperas is the basis of many dyes: it gives a fine black, though it rather subjects the material to decay, unless used with extreme caution; the least excess oc-

casioning the cloth, &c. to rot very soon. It seems that wool is more affected by it than felt, as is obvious from the greater duration of hats beyond what broad cloths, &c. exhibit when dyed black. Ink owes its rich blackness principally to the copperas it contains; and our fine black leathers are equally indebted to its powerful qualities, which so firmly fix the colour on all occasions. Many servants are in the habit of cleansing their copper kitchen utensils with green vitriol, which is extremely dangerous: the copperas is highly corrosive, and disengages a very large portion of the copper, which cannot be always removed, even when much pains are taken, the salt being buried under projecting rims, rivets, &c. We are apt to believe that many most painful and dangerous complaints have resulted from this, though probably they may have been assigned to other supposed causes.

Mr. Murdoch, of Cornwall, obtained a patent for extracting copperas from mundic, and other ores containing sulphur, zinc, or arsenic. He washes the calcined mundic, &c. and by evaporating the liquid produces chrystals of copperas. It is probably owing in a great degree to the quantity of green vitriol it contains, that ink is so efficacious in the cure of burns where the skin is not off; but it should be applied without delay. Where copperas comes in contact with metals, it occasions an oxide to be formed, which is highly prejudicial to linens, &c. as well as to health. When it acts upon iron it produces a stain called iron-mould, which may, however, be easily removed, if attended to in due time, by the use of vegetable acids; especially the salt of lemons, and partially by cream of tartar, which is often sold by those itinerant knaves, who impose on the ignorant throughout the country, for the concentrated salt of that fruit.

COPROSMA, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx one-leafed, five-toothed; corolla five or six cleft; stamina five, six, or seven. Herm. styles two, long; berry containing two, flattish seeds. There are two species, *viz.* C. foetidissima, and C. lucida, both shrubs; leaves opposite, with a stipule interposing; peduncles axillary, one, or many-flowered; flowers male and hermaphrodite; corolla differently divided, and the number of stamens uncertain, from five to seven. These were discovered in Queen Charlotte's Sound, New Zealand.

COPULA, in logic, the verb that connects any two terms in an affirmative or negative; as "riches make a man happy;" where *make* is the copula: "no weakness is a virtue;" where *is* is the copula.

COPULATIVE *propositions*, in logic, those where the subject and predicate are so linked together, by copulative conjunctions, that they may be all severally affirmed or denied one of another. Example, "Riches and honours are apt to elate the mind, and increase the number of our desires."

COPY, in a law sense, signifies the transcript of any original writing, as the copy of a patent, charter, deed, &c. A common deed cannot be proved by a copy or counterpart, where the original may be procured. But if the deed be inrolled, certifying an attested copy, is proof of the inrollment, and such copy may be given in evidence.

Copy is also used for the imitation of an original work, more particularly in painting, draught, figure, &c.

Copy, among printers, denotes the manuscript, or original of a book, given to be printed.

Copy is used for an imitation of any original work, particularly a painting, drawing, figure, &c. Of late years many methods have been invented for taking copies of letters, or other MS., for the convenience of merchants, &c. Mr. Watt, of Birmingham, obtained a patent for a copying machine, which acts as a rolling press: the ink made use of is of a particular quality, which prevents its drying too quickly, and the paper on which the copy is to be taken is unsized, and in other respects prepared for the purpose. There have been other contrivances of polygraphs for making two or more copies at the same time of any writing. But the most simple method, where the practice is not much called for, consists in putting a little sugar in common writing ink, and with this the writing is made on common paper; and when a copy is required, unsized paper is taken and lightly moistened with a sponge. The wet paper is then applied to the writing, and a flat iron of a moderate heat being lightly passed over the unsized paper, the copy is immediately produced. The use of the sugar is to prevent the ink from drying too soon.

Copy-*hold*, a tenure for which a tenant has nothing to shew but the copy of the

rolls made by the steward of the lord's court.

The customs of manors differ as much as the humour and temper of the respective ancient lords, so a copyholder, by custom may be tenant in fee-simple, in fee-tail, for life, by the courtesy, in dower, for years, at sufferance, or on condition; subject, however, to be deprived of these estates upon the concurrence of those circumstances which the will of the lords, promulged by immemorial custom, hath declared to be a forfeiture or absolute determination of those interests; as in some manors the want of issue, in others the want of issue male, in others the cutting down timber, in others the non-payment of rent or fine. Yet none of these interests amount to freehold; for the freehold of the whole manor abides always with the lord only, who hath granted out the use of occupation, but not the corporeal seizin, or true possession of certain parts or parcels thereof, to these his customary tenants at will.

If a person would devise a copyhold estate, he cannot do it by his will, but he must surrender to the use of his last will and testament, and in his will declare his intent; and here the lands do not pass by the will, but by the surrender thus made.

Copyhold inheritances have no collateral qualities, which do not concern the descent, as to make them assets to bind the heir, or whereof the wife may be endowed, &c. They are not extendible in execution, but are within the acts against bankrupts, and the statutes of limitation.

Copy-*holder*, one who is admitted tenant of lands or tenements within a manor, which, time out of mind, by use and custom of the manor, have been demisable and demised to such as will take them in fee-simple, or fee-tale, for life, years, or at will, according to the custom of the manor by copy of court-roll. But is generally where the tenant has such estate either in fee or for three lives.

Copy-*right*, the right which an author may be supposed to have in his own original literary compositions; so that no other person, without his leave, may publish or make profit of the copies. When a man, by the exertion of his rational powers, has produced an original work, he has clearly a right to dispose of that identical work as he pleases; and any attempt to take it from him, or vary the disposition he has made of it, is an invasion of his right of property. Now the identity of a literary composition consists entirely in the sentiment and the language; the same conceptions, clothed in the same words, must necessarily be the same composition: and whatever method be taken of conveying that composition to the ear, or to the eye of another, by recital, by writing, or by printing, in any number of copies, or at any period of time, it is always the identical work of the author which is so conveyed; and no other man (it hath been thought) can have a right to convey or transfer it, without his consent either tacitly or expressly given. This consent may, perhaps, be tacitly given when an author permits his work to be published without any reserve of right, and without stamping on it any marks of ownership; it is then a present to the public, like the building of a church, or the laying out a new highway: but in case of a bargain for a single impression, or a total sale or gift of the copy-right; in the one case the reversion hath been thought to continue in the original proprietor; in the other the whole property, with its exclusive rights, to be perpetually transferred to the grantee. On the other hand it is urged, that though the exclusive right of the manuscript, and all which it contains, belongs undoubtedly to the owner before it is printed or published; yet from the instant of publication the exclusive right of an author, or his assigns, to the sole communication of his ideas immediately vanishes and evaporates, as being a right of too subtle and unsubstantial a nature to become the subject of property at the common law, and only capable of being guarded by positive statute and special provisions of the magistrate.

COR *Caroli*, in astronomy, an extra-constellated star in the northern hemisphere, situated between the Coma Berenices, and Ursa Major, so called by Dr. Halley in honour of King Charles.

Cor *Hydræ*, a fixed star of the first magnitude, in the constellation of Hydra.

Cor *Leonis*, or *Regulus*, in astronomy, a fixed star of the first magnitude, in the constellation Leo.

CORACIAS, the *roller*, in natural history, a genus of birds of the order Picæ. Generic character: bill straight, bending towards the tip, sharp edged, the base naked of feathers; tongue cartilaginous and bifid; legs short; feet formed for walking, three toes before and one behind, divided throughout. There are, according to Gme-

lin, 25 species; though Latham enumerates but 16. The following is the principal. C. garrulus, or the common roller. These birds are about the size of a jay, and abound in several parts of Europe. They are found in the latitudes between Denmark and Africa; and in Sicily and Malta, as well as in Germany, are sold in the shops and markets for food. Being birds of passage they are supposed to spend the winter in Africa, as they are stated to be seen at Senegal not unfrequently in flocks. They build in trees, though sometimes in holes in the ground, and feed on insects, worms, frogs, nuts, and corn. Their flesh has very much the taste of a turtle. Its name is derived from a noise made by it similar to chattering.

CORAL. By this designation we generally understand that substance of which a variety of ornaments are made, considering it as a concrete substance, and supposing it to be a marine plant. This was the opinion entertained for centuries, from the time even of Pliny to the beginning of the seventeenth century, when various circumstances gave rise to doubts as to the formation of coral. Monsieur de Peyssounel of Marseilles observed, that the ramifications were inhabited by a numerous tribe of insects; and, that what appeared to be the flowers of the coral, and which receded into small apertures, on its being withdrawn from the salt water, were those insects, which, on re-immersion, again protruded themselves. Added to this, the softness of the terminations of all the points, and their being filled with a milky fluid, gives just reason to conclude that nature has not been deficient in providing these insects with both the means of forming their abodes, and with the means of subsistence. What that subsistence may be, or to what purpose or how the milky fluid is formed, naturalists have not yet discovered. It should seem, that the main channels in the principal branches are gradually formed, and that the lateral ramifications are produced by the expulsion of supernumeraries in the family, which attach themselves to the exterior, and form new galleries. This is the more probable, because pieces of coral, broken off from the main branches, in a few days are found to be again cemented to such parts as they may happen to light upon. By this we may also infer, that a state of rest is necessary to the existence of the coral insect, and that it has very powerful means of attaching itself to rocks, &c. Coral is generally found covered with a rugged incrustation, and on being left to dry in the sun, soon appears discoloured, and emits a very fœtid smell, arising from the corruption of the polypi, or insects, that have died for want of their natural element, and of food. The incrustation being decoriated, the coral presents itself; mostly of a beautiful blood red colour; some is white, and a few pieces are black. The latter is much valued, but the red only is used in medicine as an astringent. Vegetable distilled oils dissolve coral; the red kind yields, by distillation in a retort, a volatile vitreous spirit that effervesces with acids, turns syrup of violets green, and causes the solution of corrosive sublimate to assume a milky appearance. Calcined in a gentle heat it becomes white, and it imparts to all the menstrua a red colour, which itself gradually loses. The white coral is little valued, and is generally made into lime of the finest quality, where it grows in abundance between high and low water mark. Fisheries for red and black coral are established in many parts of the world, principally in the Levant, in the Red Sea, Peruvian Gulf, Chinese Seas, and among many of the numerous clusters of islands in the Eastern and Pacific Oceans. The largest, brightest, and heaviest, is accounted the best. The women of Asia wear necklaces and bracelets, made of one or more rows of red coral; there called moongah. Although obtained in their own quarter of the world, the beads are very dear; those of about the size of a large marrow-fat pea being usually sold for four or five rupees per tolah, of half an ounce; which is equal to sixteen or twenty pounds sterling for a pound avoirdupois. The natives of Hindostan have a mode of imitating coral, by means of the butts of large conch-shells, which they colour very artfully. Coral is sometimes found in a fossil state, but invariably of a white or yellowish colour: these, from some remaining red spots in their interior, appear to have been formerly entirely of that colour, but to have lost it by absorption, or by the action of acids: and the colour of coral is by no means fixed: if a pound of red coral (the isis nobilis of Linnæus) be boiled in a strong syrup, in which a pound of wax is mixed, both being previously dissolved in spirits of wine, the whole colouring matter of the coral may be extracted. Artificial coral is made of levigated cinnabar or of minium; but these are easily detected: they will not

effervesce with acids, nor do they afford an alkaline earth, as real coral invariably does.

CORALLINA, *Coralline*, in natural history, a genus of the Vermes Zoophyta: Animal growing in the form of a plant; stem fixed, with calcareous subdivided branches, mostly jointed. C. officinalis is common on almost every shore, growing in clustered tufts from two to five inches long, about the thickness of a large thread; white, greenish, yellowish, purple, or reddish, and frequently a mixture of all the colours. This is the species sometimes used in powder as an absorbent and vermifuge. C. flabellum inhabits the West Indies, of various colours, from a greenish-brown to milk-white; sometimes of a flat kidney-shaped form, and about an inch high; sometimes expanding to a large subdivided lobed and undulated mass from one to five inches high, and as many broad: stem terminated by a tuft of fine radical tubes.

CORCHORUS, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Columniferæ. Tiliaceæ Jussieu. Essential character: corolla five petalled; calyx five-leaved, deciduous; capsule many valved, many seeded. There are sixteen species. Natives of both Indies.

CORCULUM, in botany, a term used by Linnæus for the heart, or more properly embryo, of a seed, alluding to its shape, which in the walnut, and many other seeds, resembles the animal heart in miniature. It is the most important, and even essential part of a perfect seed, to which all the rest are subservient, being the point whence the future plant originates. In unimpregnated seeds it is deficient, or rather abortive; in fertile ones it is closely connected with the cotyledons, on which it depends for the first supplies of nutriment, and other exciting causes of its evolution. The corculum consists of the radicle, which descends to become a root, and the plumula or feather which ascends and becomes the stem and leaves.

CORD, *magical*, an instrument in great use among the Laplanders, and supposed to possess considerable virtues in certain magical rites and ceremonies. When properly prepared with knots, it is supposed to have power over the winds; and by means of it they will sell a favourable wind to any one that has faith enough to become a purchaser. If they untie only one of these knots, a moderate gale is to succeed; if two it is much stronger, and if three there is to be a storm.

CORD *of wood*, a certain quantity of wood for burning, so called, because formerly measured with a cord. The dimensions of a statute cord of wood are eight feet long, four feet high, and four feet broad.

CORDAGE, a term used, in general, for all sorts of cord, whether small, middling, or great, made use of in the rigging of ships. Cordage, cable-laid, as the seamen term it, is made with nine strands, *i. e.* the first three strands are laid slack, and then three of them, being closed together, make a cable, or cablet. See CABLE, ROPE, &c.

CORDIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ Jussieu. Essential character: corolla funnel-form; style dichotomous; drupe with two-celled nuts. There are twelve species, of which one is C. myxa, smooth-leaved cordia, sebesten, or Assyrian plum. The leaves of this tree are about three inches long, opposite, flat, entire, on a round petiole half an inch in length; peduncles panicled, terminating, subcorymbed; petals white, revolute; fruit inferior, red, nearly an inch in diameter. The timber of this tree is tough and solid; it is used for procuring fire by friction. A native of Arabia and the East Indies.

CORDIAL, in medicine, whatever raises the spirits, and gives them a sudden strength and cheerfulness.

CORDON, in fortification, a row of stones, made round on the outside, and set between the wall of the fortress, which lies aslope, and the parapet which stands perpendicular, after such a manner, that this difference may not be offensive to the eye: whence the cordons serve only as an ornament, ranging round about the place, being only used in fortification of stone-work. For in those made with earth, the void space is filled up with pointed stakes.

CORDWAINERS, a term whereby shoemakers are denominated in statutes; By a statute of Jac. I. the master and wardens of the cordwainers company, &c. are to appoint searchers and triers of leather; and no leather is to be sold, before searched, sealed, &c.

CORDYLOCARPUS, in botany, a genus of the Tetradynamia Siliquosa class and order. Silique cylindrical, swelling into knobs, jointed, the uppermost joint distinct; calyx closed. Two species found in the Archipelago.

COREOPSIS, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ Jussieu. Essential character: calyx erect, many-leaved, surrounded at the base with spreading rays; down two-horned; receptacle chaffy. There are twenty species.

CORIANDRUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: corolla rayed; petal inflex emarginate; involucre universal, one-leafed; partial halved; fruit spherical. There are two species, *viz.* C. sativum, common or great coriander, has an annual root, the stem about a foot and half in height; universal involucre one-leafed or none, the three leaflets of the partial involucre small, filiform; petals white or reddish. It flowers in June or July in corn fields. C. testiculatum, small or twin-fruited coriander; root annual; stem angular; umbel usually simple, very seldom compound; universal involucre one-leafed; partial none; petals not rayed; anthers purplish. The leaves of this sort, as well as the former, have a strong disagreeable scent. The seeds are grateful to the taste, and incrusted with sugar are sold by the confectioners. The first sort, though found wild in Essex, where it has been long cultivated, is not a native of this country. They are both brought from the South of Europe, China, and Cochin China.

CORIARIA, in botany, a genus of the Dioecia Decandria class and order. Essential character: calyx five leaved; corolla five petalled, very like the calyx. Male, anthers two parted. Female, styles five; seeds five, covered with succulent berried petals. There are three species.

CORIS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Lysimachiæ, Jussieu. Essential character: corolla one-petalled, irregular; calyx spinous; capsule five-valved, superior. There is but one species, *viz.* C. monspeliensis, Montpelier coris. This plant is seldom more than six inches high, and spreads near the surface of the ground like heath. It flowers in June, and makes a very pretty appearance. There are two varieties of this plant, one with a red and the other with a white flower. Native of the South of France.

CORISPERMUM, in botany, a genus of the Monandria Digynia class and order. Natural order of Oleraceæ. Atriplices, Jussieu. Essential character: calyx none; petals two; seed one, oval, naked. There are two species, *viz.* C. hyssopifolium, hyssop-leaved tickseed, and C. squarrosum, rough-spiked tickseed. These plants having little beauty are seldom cultivated, except in botanic gardens. They are natives of Russia.

CORK, is a substance analogous to wood, it is the exterior bark of a tree belonging to the genus oak, which grows wild in the southern parts of Europe. When the tree is fourteen or fifteen years old it is fit to be barked, and may be done successively for several years. The bark always grows up again, and its quality improves as the age of the tree increases. If the bark is not taken off in due time it splits and peels off by itself, being pushed away by the second growth. The best bark comes from Spain and Portugal: it is taken off in sheets, care being used in keeping them as large as possible. After it is detached from the tree the Portuguese burn or char it, laying the convex side of the bark to the fire in order to straighten and swell it. It is then piled in stacks ready for sale.

Cork is formed into soles for shoes, into corks and bungs for stopping bottles, &c. into a floatage for the nets of fishermen; it is employed generally, though perhaps with a considerable degree of error, in teaching the art of swimming; it is also ingeniously used, on account of its lightness, when an amputation of the human leg has been necessary, to supply the deficiency; the Spaniards line stone walls with it, which not only renders their houses very warm but corrects the moisture of the air; the Egyptians made coffins of it, which being covered in the inside with a resinous composition preserved their dead bodies. It is burnt to make that light black substance called Spanish black, from its having been first made in Spain.

Cork bark has not only been applied as above, but also in the preservation of life when endangered by shipwreck; the most conspicuous exhibition of its advantages is in the application of it in the construction of the "life boat," or "cork boat," as it was originally called. See BOAT, *life*.

A cork jacket too has been revived from an old German discovery, by Mr. Dubourg; to preserve the lives of persons in danger of drowning, which is constructed as follows: pieces of cork about three inches long, by two wide, and the usual thickness of the

bark, are inclosed between two pieces of strong cloth or canvass, and formed like a jacket without sleeves; the pieces of cloth are sewed together round each piece of cork to keep them in their proper situations; the lower part of the jacket, about the hips, is made like the same part of womens' stays, to give freedom to the thighs in swimming; it is made sufficiently large to fit a robust man, and is secured to the body by two or three strong tapes sewed far back on each side, and tied before; the strings are thus placed to enable any wearer to tighten it to his own convenience. Cork in its action has the elasticity of a spring, and when pressed into any aperture it exerts a force acting outwardly on all sides from the centre. It is this quality that makes it valuable in shutting out the external air from liquors and elastic fluids; and it is fitted for this purpose in a degree proportioned to the impermeability of its pores. The elasticity of cork has also been employed for many other purposes in the arts; it forms the spring of the lifter in ordinary candlesticks, and where the frame is not heavy it can be made into a good substitute for the pulleys and weights of the sashes of windows.

CORK *cutting*, or the manufacturing of corks. This business, though it is thought one of the most dirty, is not one of the least profitable; it is likewise easy in the acquirement. The cork, after being pressed into square pieces, is received by the cork-cutters, and if not sufficiently flat for their purpose, they "lay" it again over a fire in their "burning-yard," turning the convex part to the flame; the heat, by twisting the edges of the bark, counteracts the natural bend, and compels it to receive a flat form. During this operation, a considerable degree of attention is paid to smoothing it, and particularly again to cover its defects. It is next cut into slips, narrow or wide, according to the intended cork, bung, or tap, for such are the names of the general divisions in this business. The use of the two former is well known, the latter is used for stopping the tap-holes of barrels, as the name implies. These slips are again cut into squares, of a length proportioned to the use they are intended for. This operation is performed by one man, from whom they are handed forward to several others. A further division of corks takes place, of these different sorts, according to their lengths, and are denominated "short," "short long," and "full long." The cork-maker places himself before the table or plank, on which is fastened a board about three inches thick, four broad, and twelve long: immediately on a line with his left hand is a piece of wood rising about four inches from the board, and fixed about the middle of it, on which the cork is laid after being cut as above. This wood not only supports the cork, and is as a guide to the workman, but by its elevation above the board gives room for the knife to cut a part of the cork in a smooth and circular manner, without striking on the table below. The piece is then turned to where the last cut ceased, and this is continued until the knife has gone completely round; the top and bottom are then pared level, and the cork thrown into a box or basket with the rest of the same length. As the bark is not of the same quality throughout each piece, the corks are sorted by a boy into four kinds, "superfine," "fine," "common," and "coarse," and are sold accordingly. The only tool employed by the cork-cutter is a knife about three inches broad in the blade, and about six inches long, very thin and sharp, and equal in breadth from the handle nearly to the end, which is finished by a gentle curve. This knife he sharpens upon the board where the guard is placed, by one whet or stroke on each side, after every cut, and now and then upon a common whetstone.

From the foregoing review it is evident, that the art of a corkcutter is principally to obtain a regular, round, and quick turn of the wrist, in guiding the knife so as to complete a pretty correct circle, and to make a smooth surface; it is on this account that the knife must be particularly sharp, to enable the workman to turn it with ease. Cork received into the stomach, in its crude state, is very deleterious: but after it has undergone certain processes it is used in medicine. It contains a small quantity of very powerful acid called suberic acid. This acid may be obtained in a solid form, but is not crystallizable: it is either pulverulent when it has been precipitated, or when obtained by evaporation is in thin irregular pellicles. Its taste is slightly bitter and acid: dissolved in a small quantity of boiling water, it is irritating to the throat, and excites coughing. It reddens the vegetable colours, and it attracts a little humidity from the air, especially when it is not perfectly pure. Exposed to heat, it is volatilized, and forms crystalline flakes on the sides of the vessel. Heated by the

blow-pipe, it first liquifies, then becomes pulverulent, and lastly is sublimed, exhaling an odour of sebacic acid. It becomes brown from exposure to light. At the temperature of 60°, an ounce of water dissolves 10 grains of the concrete acid, but if it is very pure, not more than 4 grains. Boiling water dissolves half its weight. It is not altered by oxygen gas. The mineral, or the other vegetable acids, have little action on it, and do not completely dissolve it, especially when it is not quite pure. Alcohol developes in it an aromatic odour.

Suberic acid unites easily with the alkalies and earths. Its salts are named suberates. The mineral acids in general precipitate the suberic acid from their solutions; and they are decomposed by solutions of almost all the metallic salts. Suberic acid has no action on platina, gold, or nickel; but it forms salts with the greater number of the other metals. In general these salts do not crystallize, and they have a tendency to form with an excess of acid. Its action on some metallic solutions give some appearances which may serve to distinguish it. It decomposes acetite and nitrate of lead, and nitrates of mercury and silver: with nitrate of copper it forms no precipitate, but the blue colour of the solution passes to green, as does also that of sulphate of copper: the solution of sulphate of iron becomes of a deep yellow, and that of sulphate of zinc of a clear golden yellow. A character peculiar to it is, that when a few drops of it are added to a solution of indigo in sulphuric acid, it causes the blue colour to pass to a green.

The characters by which it is distinguished from the known vegetable acids, are 1. from the citric, by not crystallizing; 2. from the gallic, by not precipitating iron black; 3. from the mallic, by being obtained in a concrete form; 4. from the tartaric, by its volatility; 5. from the oxalic, by not precipitating the solution of sulphate of copper, and by yielding to it lime. From these, and the various phenomena presented in its combinations, it is considered as different from all the other acids.

CORN, in country affairs, the grain or seeds of plants, separated from the ear, and used for making bread. See AGRICULTURE.

CORN *trade*. It is evidently desirable in every nation, that there should be plenty of the principal articles of food; and likewise that the money price of it should be as low as possible. The policy of every country, with regard to corn, should be directed to these two capital objects.

It is found by universal experience, that there is no method of favouring the production of any article so safe and advantageous as the securing of a good price to the producer; and this end is answered in England by permitting the exportation of corn when it is cheap; and enabling the producer, by means of a bounty that usually is at least equal to the expense of carriage, to sell his corn in other countries as cheaply as the farmers of those countries. With this view the bounty on the exportation of corn was originally granted, and this end it is supposed to have answered.

The general objection to all bounties has already been stated. See BOUNTY. With regard to the bounty on the exportation of corn it may be observed, that in consequence of it, the money price of corn has probably been higher, than, *cæt. par.*, it otherwise would have been: but the money price of corn regulates the money price of labour, and, consequently, the money price of all the productions of labour must be enhanced, by whatever enhances the money price of corn. The bounty, therefore, has probably rendered the money price of all articles of British industry rather higher than it otherwise would have been. Now this bad effect could not arise from a bounty on production, to be paid to the grower whenever the market price was below a certain sum; or to be paid regularly for every bushel of wheat grown. If a bounty, therefore, be necessary, it seems more desirable that it should be given for production than for exportation.

But as the quantity of corn produced depends not merely on the diligence and skill of the farmer, but on the nature of the seasons; some degree of uncertainty will necessarily exist with regard to the supply for any particular year. The proportion between the supply and the demand will vary, and the price consequently will fluctuate. Popular prejudice always ascribes scarcities to the farmer, the miller, or the corn-dealer; but an enlightened policy must regard all of these whose capitals enable them to keep a large stock, and especially the last, as most beneficially employed. It is their interest to watch the market; to ascertain the quantity produced, and to suit the supply to the demand. They purchase when they find the market overstocked; they sell when it is understocked; they keep a quantity in reserve when a scarcity

is apprehended, and all their activity and property is perpetually exerted to prevent the dreadful extremity of a famine.

CORN, in medicine and surgery, a hard tubercle like a flat wart, growing in several parts of the feet, especially upon the joints of the toes. This disorder is attributed to the wearing of too strait or narrow-toed shoes, which never fail to produce these tubercles, especially if the person is obliged to stand or walk much, and in the summertime. Various are the methods used for removing these callosities of the skin and cuticle; some by knife, and others by application of emollient and caustic or eroding medicines.

As few things are more troublesome than corns in the feet to those who have much walking, we may observe that the pressure may be prevented in the following manner: Take a piece of linen, spread with any emollient plaster; lay one piece over another, eight, or ten, or more times, and cut a hole in the middle of them, exactly the same size and circumference as the corn, then apply it in such a way that the corn enters the hole in the plaster, and is thus defended against the contact of shoes and stockings. Such a plaster, properly applied, will frequently, in a few weeks, disappear without any other remedy. If the corn is at the bottom of the foot, a hole cut in a felt sole, so as to fit the corn, is sufficient. When this method is found inefficient, rub the corn with the volatile liniment, two or three times, in the twenty-four hours, keeping it covered in the intervals with an emollient plaster. Every morning and evening the foot must be kept in warm water for half an hour, and the corn well rubbed with soap. When softened with the water, it should be scraped with a blunt knife till the soft part is removed, and till the operation begin to give pain. This treatment is to be continued till the corn is entirely extirpated.

CORNEA *tunica*, in anatomy, the second coat of the eye, so called from its substance, which resembles the horn of a lanthorn. See EYE.

CORNET, in the military art of the ancients, an instrument much in the nature of a trumpet, which when it only sounded, the ensigns were to march alone, without the soldiers; whereas, when the trumpet only sounded, the soldiers were to move without the ensigns. The cornets and buccinæ sounded the charge and retreat, and the cornets and trumpets sounded during the course of the battle.

CORNET, in the military art of the moderns, the third commission officer in a troop of horse or dragoons. This is a very honourable post: he commands in the lieutenant's absence; his principal duty being to carry the standard, near the middle of the first rank of the squadron.

CORNEUS, the name by which Linnæus calls a kind of tin ore, found in black columns, with irregular sides, and terminating in prisms. See TIN.

CORNICE. See ARCHITECTURE.

CORNUCOPIA, *or horn of plenty*, among painters, &c. is represented under the figure of a large horn, out of which issue fruits, flowers, &c. Upon medals the cornucopia is given to all deities, genii, and heroes, to mark the felicity and abundance of all the wealth procured by the goodness of the former, or the care and valour of the latter.

CORNUCOPIÆ, in botany, so called from the manner in which the flowers grow within their involucre, like a cornucopia, or horn of plenty, a genus of the Triandria Digynia class and order. Natural order of Gramina or Grasses. Essential character: involucre one-leafed, funnel-form, crenate, many-flowered; calyx two-valved; corolla one-valved. There are two species, of which is C. cucullatum; Hooded cornucopiæ, the root of this is annual, fibrous, and branched; culms numerous, ascending, jointed, smooth, branched, leafy, dark purple at the joints; flowers several, arising from the sheaths of the upper leaves; calyx and corolla striated, obtuse; filaments projecting very far; styles connected at the base, spreading in the upper part, twisted, the length of the stamens. Native of the vales about Smyrna, whence it was sent to England.

CORNUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Caprifolia Jussieu. Essential character: involucre generally four-leaved; petals four superior; drupe with a two-celled nut. There are twelve species, of which C. florida, great flowered dogwood, seldom rises above seven or eight feet, and is generally furnished with large leaves. It does not flower here very plentifully, nor does it produce berries in England, though it is very hardy.

CORNUTIA, in botany, a genus of the Didynamia Gymnospermia class and order.

Natural order of Personatæ. Vitices Jussieu. Essential character: calyx five-toothed; stamina longer than the corolla; style very long; berry one-seeded. There are two species, *viz.* C. pyramidata; hoary-leaved cornutia; and C. quinata; the former is a native of the West Indies, Campeachy, and la Vera Cruz, the latter of China in the woods near Canton.

COROLLA, among botanists, the most conspicuous part of a flower, surrounding the organs of generation, and composed of one or more flower-leaves, most commonly called petals, to distinguish them from the leaves of the plant: according as there is one, two, or three of these petals, the corolla is said to be monopetalous, dipetalous, tripetalous, &c.

COROLLARY is an useful consequence drawn from something already advanced or demonstrated: thus it being demonstrated that a triangle which has two equal sides, has also two angles equal; this corollary will follow, that a triangle which has three sides equal, has also its three angles equal.

CORONARIÆ, in botany, the tenth order of plants, in Linnæus Fragments of a Natural Method. Under this name Linnæus gives a great number of genera, most of which furnish very beautiful flowers, as the hyacinthus, agave, polyanthus, &c.

CORONATION, the public and solemn confirming the title, and acknowledging the right of governing to a king or queen; at which time the prince swears reciprocally to the people, to observe the laws, customs, and privileges of the kingdom, and to act and do all things conformable thereto.

CORONER, an ancient officer of this kingdom, so called because he is wholly employed for the king and crown. The office of coroners especially concerns the pleas of the crown; and they are conservators of the peace in the county where elected, being usually two for each county. Their authority is judicial and ministerial: judicial where a person comes to a violent death; to take and enter appeals of murder, pronounce judgment on outlawries, &c. and to enquire into the lands, goods, and escape of murderers, treasure-trove, wreck of the sea, deodands, &c. The ministerial power is when coroners execute the king's writs, on exception taken to the sheriff, as being party in a suit, of kin to either of the parties, or on the default of the sheriff, &c. The authority of the coroner does not terminate on the demise of the king. On default of sheriffs, coroners are to impannel juries, and to return issues on juries not appearing, &c.

The coroner shall have for his fee, upon every inquistion taken upon the view of the body slain, 13*s.* 4*d.* of the goods and chattels of him that is the slayer and murderer, if he have any goods; and if he have no goods, of such amerciament, as any township should happen to be amerced for the escape of the murderer. 3 Hen. VII. But as the said fee of 13*s.* 4*d.* is not an adequate reward for the general execution of the said office, therefore for every inquisition, not taken upon view of a body dying in gaol, the coroner shall have 20*s.* and also 9*d.* for every mile he shall be compelled to travel from his usual place of abode to take such inquisition; to be paid by order of the justices in sessions, out of the county rates. 25 Geo. II. c. 29. s. 1.

CORONILLA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-lipped, the upper teeth connate; standard scarcely longer than the wings; legume contracted between the seeds. There are fourteen species, mostly natives of the South of France, Switzerland, Italy, and Geneva.

CORPORAL, an inferior officer under a serjeant, in a company of foot, who has charge over one of the divisions, places and relieves centinels, and keeps good order in the corps de garde; he also receives the word from the inferior rounds, which passes by his corps de garde. This officer carries a fusee, and is commonly an old soldier: there are generally three corporals in each company.

CORPORAL *of a ship*, an officer who has the charge of setting and relieving the watches and centries, and who sees that the soldiers and sailors keep their arms neat and clean: he teaches them how to use their arms, and has a mate under him.

CORPORATION, a body politic, or incorporate, so called because the persons or members are joined into one body, and are qualified to take and grant, &c. Corporations are either spiritual or temporal: spiritual, as bishops, deans, archdeacons, parsons, vicars, &c. Temporal, as mayor, commonalty, bailiff, burgesses, &c. And some corporations are of a mixed nature, composed of spiritual and temporal persons, such as heads of colleges and hospi-

tals, &c. All corporations are said to be ecclesiastical or lay: ecclesiastical are either regular, as abbies, priories, chapters, &c. or secular, as bishoprics, deaneries, archdeaconries, &c.; lay, as those of cities, towns, companies, or communities of commerce, &c.

Corporations may be established three different ways, *viz.* by prescription, letters patent, or act of parliament; but are most commonly established by patent or charter. London is a corporation by prescription: but though corporations may be by prescription, yet it shall be intended, that it did originally derive its authority by a grant from the king.

A corporation may be dissolved; for it is created upon a trust, and if it be broken, it is forfeited. No person shall bear office in any corporation but such as have received the sacrament, taken oaths, &c. and none are to execute in a corporation for more than a year. A corporation cannot sue or appear in person, but by an attorney.

Ordinances made by corporations, to be observed on pain of imprisonment, forfeiture of goods, &c. are contrary to Magna Charta. Actions arising in any corporation, may be tried in the corporation courts; but if they try actions not within their jurisdictions, and encroach upon the common law, they are liable to be punished for it. The corporation of the city of London is to answer for all particular misdemeanors committed in any of the courts of justice within the city, and for all other general misdemeanors committed in the city.

CORPUSCULAR *philosophy*, that way of philosophising which endeavours to explain things, and to account for the phenomena of nature by the motion, figure, rest, position, &c. of the corpuscles, or the minute particles of matter.

Boyle reduces the principles of the corpuscular philosophy to the four following heads.

1. That there is but one universal kind of matter, which is an extended, impenetrable, and divisible substance, common to all bodies, and capable of all forms. On this head, Newton remarks thus: "All things considered, it appears probable to me, that God in the beginning created matter in solid, hard, impenetrable, moveable particles; of such sizes and figures, and with such other properties, as most conduced to the end for which he formed them; and that these primitive particles, being solids, are incomparably harder than any of the sensible porous bodies compounded of them; even so hard as never to wear or break in pieces; no other power being able to divide what God made one in the first creation. While these corpuscles remain entire, they may compose bodies of one and the same nature and texture in all ages; but should they wear away, or break in pieces, the nature of things depending on them would be changed; water and earth, composed of old worn particles, of fragments of particles, would not be of the same nature and texture now, with water and earth composed of entire particles at the beginning. And therefore, that nature may be lasting, the changes of corporeal things are to be placed only in the various separations, and new associations, of these permanent corpuscles."

2. That this matter, in order to form the vast variety of natural bodies, must have motion in some, or all its assignable parts; and that this motion was given to matter by God, the creator of all things; and has all manner of directions and tendencies. "These corpuscles, says Newton, have not only a vis inertiæ, accompanied with such passive laws of motion as naturally result from that force; but also are moved by certain active principles; such as that of gravity, and that which causes fermentation, and the cohesion of bodies."

3. That matter must also be actually divided into parts; and each of these primitive particles, fragments, or atoms of matter, must have its proper magnitude, figure, and shape.

4. That these differently sized and shaped particles, have different orders, positions, situations, and postures, from whence all the variety of compound bodies arises. See ATOMIC PHILOSOPHY: ATTRACTION.

CORREA, in botany, a genus of the Octandria Monogynia class and order: calyx campanulate, four-toothed; petals four, reflected at the ends; capsule four-celled, four-valved, with a single seed in each. One species, the alba, a shrub, is a native of Port Jackson.

CORRECTION, in printing, the pointing out or discovering the faults in a printed sheet, in order to be amended by the compositor, before it be printed off. See PRINTERS, *marks of*.

CORRIGIOLA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Holoraceæ. Portulaceæ,

Jussieu. Essential character: calyx five-leaved; petals five; seed one, three-sided. There is but one species, *viz.* C. litoralis. Bastard knot grass, a native of France, Germany, Switzerland, and Piedmont, in sandy soils, usually near the sea or rivers.

CORRIRA, the *courier*, in natural history, a genus of birds of the order Grallæ. Generic character: bill short and straight, and without teeth; legs long; thighs longer than the body; feet palmated, with a back toe. This bird, for there is only one species, is a native of Italy, and is remarkable for the extreme length of its neck as well as legs; it runs with peculiar speed, and derives, unquestionably, from this circumstance its popular designation of courier. It seems to be extremely rare, as Latham remarks that Aldrovandus was the only naturalist who had seen it, and that on his description all subsequent writers had depended.

CORROSIVE *sublimate*, an old name for the oxymuriate of mercury, or as it is called in the shops muriated mercury. If muriatic acid be added to the yellow sulphate of mercury, or to the nitrate of mercury, and muriate of mercury is formed, which is soluble in water, and which on account of its properties was formerly called corrosive sublimate, or corrosive muriate of mercury.

To obtain it, in the large way, the following process is mentioned by Mr. Murray: mix together equal parts of dry oxynitrate of mercury, decrepitated common salt, and calcined sulphate of iron. One-third of a matrass is filled with this mixture; the vessel is placed in a sand-bath and gradually heated to redness. When the apparatus is cold, oxymuriate of mercury is found sublimed in the upper part of the matrass.

Oxymuriate of mercury, when obtained by sublimation, is in the form of a beautiful white semi-transparent mass, composed of very small prismatic needles. By evaporation, it yields cubes or rhomboidal prisms, or, more commonly, quadrangular prisms with their sides alternately narrower, and terminated by dihedral summits; its specific gravity is 5.1; its taste is excessively acrid and caustic, and it leaves, for a long time, a very disagreeable styptic metallic impression on the tongue. When swallowed it is one of the most virulent poisons known, producing violent pain, nausea, and vomiting, and corroding in a very short time the stomach and intestines. It is soluble in about 20 parts of cold water. Boiling water, according to Macquer, dissolves half its weight of it. According to Wenzel, water when boiled over this salt dissolves very nearly $\frac{1}{3}$ of its weight of it. Alcohol, according to Macquer, at the temperature of 70°, dissolves $\frac{3}{8}$ths of its weight, and 100 parts of boiling alcohol dissolves 88 parts of it. It is not altered by exposure to the air. When heated it sublimes very readily; and while in the state of vapour it is exceedingly dangerous to those who are obliged to breathe it.

It is soluble in sulphuric, nitric, and muriatic acids; and may be obtained again by evaporation unaltered. It is decomposed by the fixed alkalies, and its oxide precipitated of a yellow colour, which soon becomes brick-red. This decomposition renders oxymuriate of mercury a useful test for ascertaining the presence of fixed alkalies in solution. If liquid oxymuriate of mercury be dropt into a solution containing the smallest portion of alkali, the brick-red precipitate appears. Ammonia forms with it a triple salt. The component parts of this salt are, according to Chenevex,

Oxide of mercury..........	82
Acid..........................	18
	100

Externally this substance is employed as an escharotic for destroying fungus flesh.

CORROSIVES, in surgery, are medicines which corrode whatever part of the body they are applied to: such are burnt alum, white precipitate of mercury, white vitriol, red precipitate of mercury, butter of antimony, lapis infernalis, &c.

CORRUPTION, the destruction of the proper mode of existence of any natural body.

Corruption *of blood*, in law, an infection accruing to a man's state, attainted of felony and treason, and to his issue; for as he loses all to the prince, &c. his issue cannot be heirs to him, or to any other ancestor by him; and if he were noble his heirs are rendered ignoble.

CORSELET, a little cuirass, or, according to others, an armour or coat made to cover the whole body, anciently worn by the pike-men, usually placed in the front and flanks of the battle, for the better resisting the enemy's assaults, and guarding the soldiers placed behind them.

CORTULA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Dis-

coideæ," or compound radiated flowers. Corymbiferæ, Jussieu. Essential character: receptacle almost naked; down margined; corollules of the disk four cleft; in the ray scarcely any. There are fifteen species, mostly natives of the Cape.

CORTUSA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla wheel-shaped, the throat having an elevated ring; capsule one-celled, oval, five-valved at the end. There are two species, C. matthioli, sends out many oblong smooth leaves, a little indented on the edges, forming a sort of head like the auricula; the peduncles come out in the centre of the leaves, rising about four inches high, which support an umbel of flowers, each on a slender short pedicle; they are of a flesh colour, and spread open like those of the auricula. Native of the Alps, Austria, Silesia, and Siberia, flowering in April and May. C. gmelini resembles the first, though the flowers are much smaller and the calyxes larger, this is a native of Siberia.

CORVUS, the *crow*, in natural history, a genus of birds of the order Picæ. Generic character: bill strong convex, sharp edged; nostrils covered with bristly feathers turned back over them; tongue cartilaginous and divided; toes three forward and one backward, the middle one joined to the outer as far as the first joint. The greater number of this tribe of birds are to be found in almost every country, and they are distinguishable by being gregarious, noisy, and prolific; by being in general promiscuous feeders upon animal and vegetable substances, and by laying six eggs in nests built in trees. Some naturalists reckon 41 species; Gmelin, however, specifies 48. Those most entitled to attention are the following.

C. corax, the raven. This is the largest species of the genus, and weighs three pounds, and measures in length two feet, and in breadth four. It inhabits, in the old continent, from Greenland to the Cape of Good Hope, and, in the new, from Canada to Mexico. It will destroy many animals, such as chickens, ducks, and rabbits, and sometimes even lambs, for subsistence, but appears to delight more in the putrid remains of carcases, which are to be almost every where met with on a globe perpetually changing its inhabitants. It may, in this point of view, be regarded as highly serviceable, preventing the contagion of disease in a great degree, as well as the annoyance of the senses. Its smell is particularly acute, enabling it to discriminate its favourite repast, though at a great distance. Its caution is also extraordinary, as it will rarely venture within the reach of a gun, which it appears to distinguish with particular sagacity. It is long lived, having been stated on respectable authority to live from 40 to 60 years. It is easily familiarized, but is much addicted to concealing, in holes and bye places, things of no possible advantage to itself, and which the owner is much embarrassed by the want of. It may be taught to speak. In England it builds in trees; in some other countries it builds in the holes of rocks; the duty of incubation is performed by the male during the day, and by the female in the night. The Greenlanders make use of it for food, and use its skin in the manufacture of garments, and its wings for brushes. Its feathers are split by them, and twisted into fishing lines. The raven is the only species of its genus at present existing in Greenland, which may be considered as an evidence of its robust and hardy constitution. In times of superstition this was a bird of most important augury, whose sounds were studied with the most profound attention, and frequently overwhelmed even the hero himself with terror. See Aves, Plate IV. fig. 4.

C. corone, the carrion crow, is very similar to the raven in habits and colour, but is only about half its size. It is also not so frequently to be met with.

C. frugilegus, the rook. Rooks are in France and some parts of Germany birds of passage, but in England they are stationary. They live upon various worms and the erucæ of insects, particularly those of the chafer, the extirpation of which is of extreme service to the farmer, and far more than compensates for the depredations committed by those birds themselves on the corn, which they thus usefully preserve from far more destructive plunder. Rooks are gregarious birds, and, unless when breeding, regularly repair, sometimes in immense flocks, from the place where they roosted to whatever spot of ground they may fix upon as their grand refectory, returning as the day closes in the same formidable body to their former lodging. In February they begin to build their nests, which they do in large societies of many hundreds on the tops of high trees, particularly elms. To the curious observer this process is a scene of considerable interest, exhibiting perpetual

bustle and assiduity, incessant struggle and contention, stratagem and violence. Cunning and oppression are in perpetual conflict, art is often successfully substituted for strength, and more frequently power for right. It is a circumstance within the recollection of several persons at Newcastle, that a pair of rooks, who had been interrupted in various efforts to build in a neighbouring rookery, at length actually established their nest on the weather-vane of the spire of the Exchange, and produced their young to perfection, notwithstanding all the persecutions of their enemies, all the clamorous admiration of the populace, and the movements which they experienced from every shifting breeze of wind. So tenacious were they of this situation, that they returned to it for ten successive years.

C. monedula, the jackdaw. These birds are about the size of a small pigeon, though not quite so thick. In England they are stationary, in France, Austria, and Denmark, in different degrees, migratory. They rarely build their nests in trees, preferring the ruins of human habitations, or of churches and towers, where their eggs and young are more beyond the reach of depredating school-boys. They sometimes lay in rabbit holes. They are domesticated with great facility, and may be taught to utter a considerable number of words. They are, like the raven, much addicted to concealment and pilfering, hiding not only their food, but a variety of toys and trinkets, a circumstance which has not unfrequently brought suspicion and disgrace upon the most honest and faithful domestics. See Aves, Plate IV. fig. 5.

C. glandarius, the jay. The jay weighs about seven ounces, and is about thirteen inches long. Its colours are beautifully arranged, and it attracts by its appearance that favourable and delighted attention which is somewhat counteracted by its harsh and chattering sounds. It is regarded by the sportsman with no little aversion, as its vigilance is ever upon the alert, and on the first sight of an enemy it utters those screaming sounds of alarm which warn all within its reach of danger, and defeat the hopes and aims of their adversary. Its nest is built of sticks, roots, and tender twigs, in the woods, and the young continue with their parents till the following season, when they withdraw and form establishments of their own. Jays feed on almost all sorts of seeds and fruits, on nuts and acorns, and occasionally on eggs and even chickens. They are sometimes kept in a cage, but almost uniformly lose in this confinement all the beauty of their plumage. They will imitate with great ease and accuracy a variety of sounds, and articulate a considerable number of words, and, by this acquired talent, have sometimes produced considerable mischief, setting on dogs to worry cattle, calling the dogs by their names, in imitation of the shepherd's voice; and they appear greatly to enjoy the spectacle of confusion and distress which they thus produce. The jay is not found in the south, beyond Greece or Italy, and is unknown in Ireland. See Aves, Plate IV. fig. 6.

C. pica, the magpie. This bird is extremely common in England, and is found in most countries between Sweden and Italy in Europe. In America it is rare, and is a bird of passage. Though its colours consist only of black and white, yet these are attended with such extraordinary bloom and radiance, that the plumage of one seen in a perfect state of nature will excite a very high sensation of beauty, and be considered as scarcely exceeded by any other British bird. It may easily be brought up in a state of domestication, and will speak with great ease many phrases with all the readiness of the parrot, though not with his distinct and accurate enunciation. It feeds much like the crow on promiscuous substances. It constructs its nest with peculiar dexterity, not only covering the bottom with materials of a soft and downy texture, for the comfort of its young, but fixing the entrance at the side, and wattling, of appropriate substances, a complete roof for its habitation, which is thus rendered warm, dry, and secure.

C. graculus, the red-legged crow, is common on the coasts of Devonshire and Cornwall; in Kent, Wales, and Scotland also, it is to be found. It is a turbulent, bold, and clamorous bird, builds every where in rocky situations, is voracious, and often seen snatching from its companions locusts or juniper berries, which constitute its favourite food. It flies in circles, and resembles the jackdaw in some particulars of its manners, being equally prone to pilfer and hide. It is fond of glare, and has been known to snatch up burning sticks from the hearth, and place them in situations where, if unobserved, they must have produced destructive conflagrations.

CORUNDUM, in mineralogy. Though corundum appears to have been known to Dr. Woodward, it may be said to have been

first distinguished from other minerals by Dr. Black. In 1768, Mr. Berry, a lapidary in Edinburgh, received a box of it from Dr. Anderson of Madras. Dr. Black ascertained that these specimens differed from all the stones known to Europeans; and, in consequence of its hardness it obtained the name of adamantine spar. It is found in Hindostan, not far from the river Cavery, which is south of Madras, in a rocky matrix of considerable hardness, partaking of the nature of the stone itself. It occurs also in China, and in Ceylon, Ava, &c. The Count de Bournon pointed out the resemblance between this mineral and the sapphire, in a dissertation published by him and Mr. Greville in the Philosophical Transactions for 1798, and suggested it as probable that corundum may be only a variety of the sapphire; and that the seeming difference in their ingredients is owing to the impurity of those specimens of corundum which have hitherto been brought to Europe. This conjecture has been since confirmed by a subsequent dissertation of Bournon, and the chemical analysis of Chenevix. Werner subdivides it into two species, namely, corundum, and adamantine spar; but, in reality, they seem to be only varieties, or, at most, subspecies of the same species. The chief difference exists in the colours.

Corundum has been found in India, in the Carnatic, and on the coast of Malabar. It occurs massive, in rolled pieces, and crystallized; crystals the same as in sapphire; colour greenish-white, passing into greenish-grey and asparagus-green, sometimes pearl-grey, which passes into flesh-red; surface rough; fracture foliated; specific gravity 3.7 to 4.2.

Mr. Chenevix obtained the following constituents from the specimens of the corundums, which he subjected to chemical analysis.

IMPERFECT CORUNDUM.

	From the Carnatic.	From Malabar.	From China.	From Ava.
Silica	5.0	7.0	5.25	6.5
Alumina	91.0	86.5	86.50	87.0
Iron	1.5	4.0	6.50	4.5
	97.5	97.5	98.25	98.0
Loss	2.5	2.5	1.75	2.0
	100	100	100	100

PERFECT CORUNDUM.

	Blue, or Sapphire.	Red, or Oriental Ruby.
Silica	5.25	7.0
Alumina	92.00	90.0
Iron	1.00	1.2
	97.25	98.2
Loss	1.75	1.8
	100	100

CORUSCATION, a glittering, or gleam of light issuing from any thing. It is chiefly used for a flash of lightening darting from the clouds in time of thunder. See METEOROLOGY.

CORYLUS, in botany, English *hasel*, or nut-tree, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character: male calyx one-leaved, three-cleft, scale-form, one-flowered; corolla none; stamens eight. Female calyx two-leaved, lacerated; corolla none; styles two; nut ovate. There are three species with many varieties, C. avellana, common hasel nut tree, is properly a shrub, the trunk of which is covered with a whitish cloven bark, which is smooth on the branches, frequently of a bay colour, spotted with white; the shoots are sometimes hairy, ash-coloured, and green, with white tubercles. The male catkins appear in autumn, and wait for the expansion of the female gems in spring; the styles are of a bright red colour, long, and setaceous; the flowering branches, especially those which bear the fertile flowers, are set with short fine hairs, terminating in globules; the catkins are in pairs, and of a yellowish-green colour.

CORYMBIUM, in botany, a genus of the Syngenesia Monogamia class and order. Natural order of Compositæ Discoideæ. Cinarocephalæ, Jussieu. Essential character: calyx two-leaved, one-flowered, prismatic; corolla one-petalled, regular; seed one, below the corolla, woolly. There are four species, all natives of the Cape of Good Hope.

CORYNOCARPUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Berberides, Jussieu. Essential character: nectaries five, petal-shaped, alternate with the petals, glandulous at the base. One species, found at New Zealand.

CORYPHA, in botany, *appendix palmæ*. Natural order of Palms. Essential charac-

ter: flowers hermaphrodite, six-stamened; spathe many-leaved; corolla three-petalled; pistil one; berry globose, superior, one-seeded; seed bony, globose. There are two species, *viz.* C. umbraculifera, great fan palm, and C. minor; the former of which we shall give a short description of. It scarcely flowers till it is between 30 and 40 years old. Knox describes the great fan palm under the name of tallipot; he says it is as large as a ship's mast, and very straight. The leaves are of great use, one being so broad and large that it will cover 15 or 20 men; being dried, it is very strong and limber, yet it will fold close like a fan, being then about the size of a man's arm. The whole leaf spread is round, but is cut into triangular pieces for use. Soldiers all carry them upon their heads, not only to shade them from the sun, and to keep them dry in case of rain on their march, but to make their tents for them to lie under. These leaves all grow on the top of the tree. It bears no fruit until the last year of its life; the yellow blossoms, which are very beautiful, come out on the top, spreading abroad in great branches; these come to a round, hard fruit, the size of our largest cherries, and in such abundance that one tree will yield seed enough for a country, but they are not fit for food. The flowers smell so strong, that the trees are cut down where they are near houses. It is a native of Malabar, the island of Ceylon, the Marquesas, and Friendly islands. The trunk within is only a pith, which they beat in a mortar to flower, and bake cakes of it, which taste much like white bread. The leaves also serve for covering their houses, and for writing on with an iron style. Most of the books which are shown in Europe for the Egyptian papyrus, are made from the leaves of this palm.

CORYPHÆNA, the *Coryphene*, in natural history, a genus of fishes of the order Thoracici. Generic character: head sloping suddenly downwards, gill-membrane with five rays; dorsal fin as long as the back. There are 19 species, of which the principal is C. hippuris, the common coryphene. These fishes are commonly known by the name of dolphin, and appear in the Indian and Atlantic seas in immense numbers, frequently following in the wake of ships, and seizing with extreme rapacity whatever is thrown from them at all applicable for food. Indeed, occasionally, on their being opened, their stomachs have been found to contain hard and indigestible substances. They are endowed with extraordinary strength and vigour, swim with extreme swiftness, and are perpetually in the pursuit of smaller fish, particularly the flying-fish, which has not a more mortal enemy throughout the ocean. They are of particularly rapid growth, and they are often taken both by the line and net on account of their estimation for the table. They are about the length of three feet, and display in the water the most dazzling splendor and the most exquisite combination of colours, particularly azure, green, and gold. All these vanish in a short time after the dolphin is taken from the water, exhibiting, however, incessant changes during the conflict between life and death, one moment restored to their original lustre, the next fading beyond observation, till at length bloom and vitality are both finally extinguished. During the monotony of an Indian voyage, the death of the dolphin is considered by sailors as furnishing an agreeable variety, and is, indeed, watched with singular attention and interest.

CO-SECANT, in geometry, the secant of an arch which is the complement of another to 90°.

CO-SINE, in trigonometry, the sine of an arch, which is the complement of another to 90°. See Sine and Trigonometry.

COSMEA, in botany, a genus of the Syngenesia Frustranea class and order. Receptacle chaffy; seeds four-sided, with a two or four-awned crown; calyx double, each of them of one eight-parted leaf.

COSMETIC, in physic, any medicine or preparation which renders the skin soft and white, or helps to beautify and improve the complexion, as lip-salves, cold creams, ceruss, &c.

COSMICAL, a term in astronomy, expressing one of the poetical risings of a star: thus, a star is said to rise cosmically, when it rises with the sun, or with that point of the ecliptic in which the sun is at that time: and the cosmical setting is when a star sets in the west at the same time that the sun rises in the east.

COSMOGONY, a word frequently used to denote the science of the formation of the universe.

COSMOGRAPHY, a description of the several parts of the visible world, or the art of delineating the several bodies according to their magnitudes, motions, relations, &c.

COSMOPOLITE, a term denoting a citizen of the world, or one who has no fixed residence anywhere.

CASSIGNEA, in botany, a genus of the Hexandria Monogynia class and order. Calyx inferior, five-parted; corolla four or five-petalled; capsule three-celled, opening at top; the cells about three-seeded. There are two species noticed by Lamarck, found in Bourbon and Mauritius.

COSTIVENESS. See MEDICINE.

COSTUME, a term among painters: thus, a painter must observe the costume; that is, he must make every person and thing sustain its proper character, and not only observe the story, but the circumstances, the scene of action, the country or place, and make the habits, arms, manners, proportions, and the like, to correspond.

COSTUS, in botany, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: corolla inner, inflated, ringent, the lower lip trifid. There are four species, all natives of the East and West Indies.

CO-TANGENT, the tangent of an arch, which is the complement of another to 90°.

COT, in naval affairs, a particular sort of bed-frame, suspended from the beams of a ship for the officers to sleep in. It is made of canvass, sewed in the form of a chest, about six feet long, one foot deep, and two or three wide, and is extended by a square wooden frame with a canvass bottom, on which the bed or matrass is laid. It is reckoned much more convenient at sea than either the hammocks or fixed cabins.

COTTON is the produce of the gossypium, a plant about the size of a current bush, a native of the torrid zone, though it is produced in parts of Turkey, so far as 44 or 45 degrees from the equator. The finest cotton is known by the name of cat's-claw, from its singular appearance when it breaks the pod. This kind was accidentally discovered at the island of Bourbon, and was supposed to have been introduced among some seed sent from South America to the Mauritius. The soil should be extremely well prepared, and of the best quality, for the reception of cotton seed, which is usually sown in November or December, after the periodical rains in tropical climates, and ripens in May or June; when the numerous pods, which are about the size of large gooseberries, break, and display their downy contents. These are picked, and after the husks have been disengaged, the cotton is put to a small mill, consisting of two bright steel rollers, each about an inch in diameter, set parallel within the distance of about the 20th part of an inch. These rollers move different ways, and draw the cotton through between them, while the seeds are forced out of the respective little balls of down in which they are enclosed, and drop into a bag. The generality of cotton is white; but some is of a nankeen colour, and is invaluable in the manufacture of that article, as it fades very little, even with long use and frequent washing. The elasticity of cotton is inconceivable! It may be pressed into a 50th part of the space into which the strongest packers can reduce it by personal exertion: large screws are erected at many sea-ports where cotton is shipped, for the purpose of bringing the bales into the smallest compass, so as to save freight. Cotton can only be imported as a raw material, in which form it comes to us from the Levant, the West Indies, South America, and the East Indies. In the last quarter there are some kinds indigenous, but some are exotics. The name is obviously derived from the Arabic appellation *kuter*, which leads us to suppose the cultivation may have originated in Arabia. The amazing export of cotton fabrics from our settlements in the East, created for some time a necessity for the manufacturers to import the raw material, and in a few instances the thread, from the country where cotton is cultivated to an immense extent, and where a very fine sort is produced, far superior to what the Levant or the West Indies furnish. Of late years, however, the great demand for this material has excited a strong spirit of enterprize, and enabled the British colonies to raise nearly as much as the looms of the country, and the demand of the mother country, generally require. It is a highly dangerous cargo, being very subject to take fire if at all damp when packed, or if the smallest spark should reach it; in either case it will burn very slowly for weeks; but when the hold is opened, and air supplied, bursts forth with inconceivable fury. There is a species of silky down produced in pods, (similar to those of the cotton plant) on a very large tree, called the seemul. It is only fit to fill beds. Specimens of it have passed through various hands; but this kind of cotton is so peculiarly glossy, and the fibre is so short, that it could neither be carded nor spun. When mixed with rabbet's fur, &c. to make hats, it always separated. It also failed in paper-making; otherwise its abundance and cheapness would have rendered it highly valuable.

COTTON, *carding of*, as a preparation for

spinning, used formerly to be performed by the hand, with a single pair of cards, upon the knee; but this being a tedious method, ill suited to the rapid operations of the new spinning machines, other methods were contrived for affording a quicker and more adequate supply. The first improvement for this purpose was likewise made by Mr. Hargrave, and consisted in applying two or three cards to the same board, and fixing them to a stool or stock; whence they obtained the name of stock-cards. With these one woman could perform two or three times as much work as she could do before in the common way. A still more expeditious method of carding, however, by what are commonly called cylinder cards, was soon afterwards invented, and is that which is now most commonly practised.

COTTON *spinning*, the art or process of reducing cotton-wool into yarn or thread. The most simple method for this purpose, and the only one in use for a long time in this country, was by the hand upon the well-known domestic machine called a one-thread wheel. But as the demand for cotton goods began to increase, other inventions were thought of for expediting this part of the manufacture. About 50 years ago an engine was contrived for a more easy and expeditious method of spinning cotton, and a patent was obtained; but the undertaking did not prove successful. Some years after, various machines were constructed by different persons for facilitating the spinning of cotton; but without producing any very material or lasting advantage. At length, about 1767, Mr. James Hargrave, a weaver in the neighbourhood of Blackburne, in Lancashire, constructed a machine by which a great number of threads (from 20 to 80) might be spun at once, and for which he obtained his Majesty's latters patent. This machine is called a jenny, and is the best contrivance for spinning woof, or shute, that has hitherto appeared. It is now commonly constructed for 84 threads; and with it one person can spin 100 English hanks in the day, each hank containing 840 yards.

The next and most capital improvements which this branch of manufacture received were from Mr. Arkwright, afterward Sir Richard Arkwright, of Cromford, in Derbyshire. He first brought forward his new method of spinning cotton in 1768, for which he obtained a patent in 1769. In 1775 he obtained another patent for engines which he had constructed to prepare the materials for spinning; though one of these patents, being challenged at law, was set aside some years before it expired. The result of Mr. Arkwright's different inventions and improvements is a combination of machinery, by which cotton is carded, roved, and spun, with the utmost exactness and equality; and such a degree of perfection attained in spinning warp as is not to be equalled in any other part of the world. To these improvements this country is entirely indebted for the great extent of its cotton manufactures; large buildings having been erected for that branch both in England and Scotland, many of which contain several thousands of spindles, each driven by one or more large water wheels; and some of such extent as to spin at the rate of one thousand yards of twist or warp yarn in the minute. Other machines have been invented at different times, and a variety of improvements made by different mechanics and manufacturers, one of which in particular we must not omit to mention. It is called a mule, being a kind of mixture of machinery between the warp-machine of Mr. Arkwright and the woof-machine, or hand jenny, of Mr. Hargrave, and was also invented in Lancashire.

COTTON *mills* are large buildings, with peculiar machinery for carding, roving, and spinning cotton. These were entirely unknown in this country before the different inventions and improvements of Messrs. Arkwright and Hargrave; since which time great numbers have been erected in England, many in Scotland, and some in Ireland. See MANUFACTURE *of cotton.*

COTTUS, the *bull-head*, in natural history, a genus of fishes of the order Thoracici. Generic character: head broader than the body, spiny; eyes vertical and supplied with a nictitating membrane; gill membrane, of six rays; body round, without scales, tapering towards the tail; dorsal fins generally two. There are ten species, of which the principal is C. gobio, the river bull-head. This is about five inches long when full grown, is found in almost every part of Europe in clear streams, and conceals itself under a stone, or in the gravel. Its food consists of worms, aquatic insects, and extremely young fish. It is reported to deposit its spawn in a hole in the gravel formed by it for the purpose, and which nothing but necessity will induce it to leave. It is capable of swimming very vigorously and rapidly, but is far more stationary than active in its habit. It is used as food, but

almost exclusively by the poor. The mailed bull-head, or C. cataphractus, is found in abundance in the seas of Europe. For a representation of it see Pisces, Plate III. fig. 2.

COTYLEDON. A seed consists of three parts: *viz.* the cotyledons, the radicle, and the plumula, which are usually inclosed in a cover. If we take a garden bean, we may perceive each of these three parts with great ease; for this seed is of so large a size, that all its organs are exceedingly distinct. When we strip off the external coats of the bean, which are two, and of different degrees of thickness in different parts, we find that it easily divides into two lobes, pretty nearly of the same size and figure. Each of these lobes is called a cotyledon. The cotyledons of the bean, then, are two in number. See GERMINATION.

COTYLEDON, in botany, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Sempervivæ Jussieu. Essential character: calyx five-cleft; corolla one-petalled, with five nectareous scales at the base of the germ; capsules five. There are nineteen species, almost all of them natives of the Cape.

COUCHANT, in heraldry, is understood of a lion, or other beast, when lying down, but with his head raised, which distinguishes the posture of couchant from dormant, wherein he is supposed quite stretched out and asleep.

COUCHE, in heraldry, denotes any thing lying along: thus, chevron couché, is a chevron lying sideways, with the two ends on one side of the shield, which should properly rest on the base.

COUCHING, in surgery, one of the two chief methods of curing a cataract, by couching with the needle.

COVENANT, in law, the agreement or consent of two or more by deed in writing, sealed and delivered; whereby either, or one of the parties, promises to the other that something is already done, or shall be hereafter done: he that makes the covenant, is called the covenantor, and he to whom it is made is denominated the covenantee.

A covenant is either in fact or in law. A covenant in fact is that which is expressly agreed on between the parties. In law it is that covenant which the law intends and implies, though it be not expressed in terms: as where a person grants a lease of a house, &c. for a certain term, the law will intend a covenant on the lessor's part, that the lessee shall quietly enjoy the premises during the term against all incumbrances.

There is also a covenant real, and a covenant merely personal. A covenant real, is when a person binds himself to pass some real things, as lands or tenements, or to levy a fine of lands, &c. A covenant personal, is when the same is altogether personal; as if a person, by deed, covenants with another to build him a house, or to do him some other service, &c.

COVENANT *to stand seized to use*, is where a man who has a wife, children, brother, sister, or other kindred, does by deed in writing, under hand and seal, covenant and agree, that for their provision or preferment, he and his heirs shall stand seized of the land to their use, either in fee simple, fee tail, or for life.

COVERT, in law. See COVERTURE.

COVERT *way*, or *Corridor*, in fortification, a space of ground level with the field on the edge of the ditch, three or four fathoms broad, ranging quite round the half moons, and other woks toward the country. It has a parapet raised on a level, together with its banquets and glacis. The greatest effort in sieges, is to make a lodgment on the covert-way, because the besieged usually pallisade it along the middle, and undermine it on all sides.

COVERTURE, in law, is applied to the state and condition of a married woman, who is under the power of her husband, and therefore called feme covert; and disabled to contract with any person to the detriment either of herself or husband, without his consent and privity; or allowance and confirmation thereof.

COUGH. See MEDICINE.

COULTER, in husbandry, an iron instrument fixed in the beam of a plough, and serving to cut the edge of each furrow. See PLOUGH.

COUNCIL, or COUNSEL, in a general sense, an assembly of divers considerable persons to concert measures relating to the state.

COUNCIL. In this country the law, in order to assist the King in the discharge of his duties, the maintenance of his dignity, and the exertion of his prerogative, hath assigned him a diversity of councils to advise with.

1. The first of these is the high court of parliament. See PARLIAMENT.

2. The peers of the realm are by their birth hereditary counsellors of the crown,

and may be called together by the King, to impart their advice in all matters of importance to the realm, either in time of parliament, or which hath been their principal use, when there is no parliament in being. Accordingly, Bracton, speaking of the nobility of his time, says they might properly be called "consules à consulendo; reges enim tales sibi associant ad consulendum." And in the law-books it is laid down, that the peers are created for two reasons: 1. Adconsulendum; 2. Ad defendendum regem: for which reasons the laws give them certain great and high privileges; such as freedom from arrests, &c. even when no parliament is sitting; because the law intends, that they are always assisting the King with their counsel for the commonwealth, or keeping the realm in safety by their prowess and valour.

Instances of conventions of the peers, to advise the King, have been in former times very frequent, though now fallen into disuse, by reason of the more regular meetings of parliament. Sir Edward Coke gives us an extract of a record, 5 Henry IV. concerning an exchange of lands between the King and the Earl of Northumberland. Many other instances of this kind of meeting are to be found under our ancient kings: though the formal method of convoking them had been so long left off, that when Charles I. in 1640, issued out writs under the great seal, to call a council of all the peers of England, to meet and attend his Majesty at York, previous to the meeting of the long parliament, the Earl of Clarendon mentions it as a new invention, not before heard of: that is, as he explains himself, so old, that it had not been practised in some hundreds of years. But though there had not for long time before been an instance, nor has there been any since, of assembling them in so solemn a manner, yet in cases of emergency, our princes have at several times thought proper to call for, and consult as many of the nobility as could easily be brought together; as was particularly the case with James II. after the landing of the Prince of Orange; and with the Prince of Orange himself, before he called the convention parliament, which afterwards called him to the throne. Besides this general meeting, it is usually looked upon to be the right of each particular peer of the realm, to demand an audience of the King, and to lay before him with decency and respect, such matters as he shall judge of importance to the public weal.

3. A third council belonging to the King, are according to Sir Edward Coke, his judges of the courts of law, for law-matters. And this appears frequently in the English statutes, particularly 14 Edward III. c. 5. and in other books of law. So that when the King's council is mentioned generally, it must be defined, particularized, and understood, according to the subject matter; and if the subject be of a legal nature, then by the King's council is understood his council for matters of law; namely, his judges.

4. But the principal council belonging to the King is his privy council, which is generally by way of eminence, called The Council. For an account of its constitution and powers, see COUNCIL, *Privy*.

COUNCIL, *Privy*, the primum mobile of the civil government of Great Britain, bearing part of that great weight in the government which otherwise would be too heavy upon the King.

It is composed of eminent persons, the number of whom is at the Sovereign's pleasure, who are bound by oath to advise the King to the best of their judgment, with all the fidelity and secrecy that becomes their station. The King may declare to, or conceal from, his privy council whatever he thinks fit, and has a select council out of their number, commonly called the cabinet council, with whom his Majesty determines such matters as are most important, and require the utmost secrecy. All proclamations from the King and the privy council, ought to be grounded on law, otherwise they are not binding to the subject. Privy counsellors, though but gentlemen, have precedence of all the knights and younger sons of barons and viscounts, and are styled right honourable.

COUNCIL, *Common*, in the city of London, is a court wherein are made all byelaws which bind the citizens. It consists, like the parliament, of two houses, an upper, composed of the Lord Mayor and aldermen; and a lower, of a number of common council men chosen by the several wards, as representatives of the body of the citizens.

COUNCIL *of war*, an assembly of the principal officers of an army or fleet, occasionally called by the general or admiral to concert measures for their conduct with regard to sieges, retreats, engagements, &c.

Council, in church history, an assembly of prelates and doctors, met for the regulating matters relating to the doctrine or discipline of the church.

COUNSELLOR *at law*, a person retained by a client to plead his cause in a public court of judicature. There are two degrees of counsel, *viz.* barristers and sergeants. Barristers are called to the bar after a certain period of standing in the inns of court. See Barrister. After 16 years standing they may be called to the degree of sergeant. The judges of the courts of Westminster are always admitted sergeants before they are advanced to the bench. From both sergeants and barristers the King's counsel are usually selected, the two principal of whom are called his attorney and solicitor-general. Counsel are supposed to plead gratis, and can maintain no action for their fees; and to encourage in them a freedom of speech in the lawful defence of their clients, a counsellor is not answerable for any matter by him spoken, though it should prove groundless, and reflect on the reputation of another; provided it relates to the cause which he espouses, and is suggested in his client's instructions. And notwithstanding counsellors have a special privilege to practise the law, yet they are punishable for misbehaviour by attachment. No counsel is allowed to a prisoner upon a general issue of indictment of felony, unless some point of law arise; for the court is the prisoner's only counsel.

COUNT, a nobleman who possesses a domain erected into a county. The dignity is a medium between that of a duke and a baron. See Earl. Counts were originally lords of the court, or of the Emperor's retinue, and had their name comites *a comitando*. Eusebius tells us, that Constantine divided them into three classes, of the two first the senate was composed: those of the third had no place in the senate, but enjoyed several other privileges of senators. There were counts that served on land, others at sea; some in a civil, and some in a legal capacity. The quality of count is now no more than a title which a King grants upon erecting a territory into a county, with a reserve of jurisdiction and sovereignty to himself. A count has a right to bear on his arms a coronet adorned with three precious stones, and surmounted with three large pearls, whereof these in the middle and extremities of the coronet advance above the rest. See Crown.

Count, in law, signifies the original declaration of complaint in a real action, as a declaration is in a personal one.

Count *wheel*, in the striking part of a clock, a wheel which moves round once in 12 or 24 hours. It is sometimes called the locking-wheel. See Clock.

COUNTER *barry*, or Contre *barre*, in heraldry, is the same as our bendy sinister per bend counterchanged.

Counter *bond*, a bond of indemnification, given to one who has given his bond as a security for another's payment of a debt, or the faithful discharge of his office or trust.

Counter *changed*, in heraldry, is when any field or charge is divided or parted by any line or lines of partition, consisting all interchangeably of the same tinctures.

Counter *deed*, a secret writing either before a notary or under a private seal, which destroys, invalidates, or alters a public one.

Counter *ermine*, in heraldry, is the contrary to ermine, being a black field with white spots.

COUNTERFEITS, in our law, are persons that obtain any money or goods by counterfeit letters or false tokens, who being convicted before justices of assize, or of the peace, &c. are to suffer such punishment as shall be thought fit to be inflicted, under death, as imprisonment, pillory, &c.

Counter *march*, in military affairs, a change of the face or wings of a battalion, by which means those that were in the front come to be in the rear. It also signifies returning, or marching back again.

Counter *mark*, a mark put upon goods that have been marked before. It is also used for the several marks put upon goods belonging to several persons, to shew that they must not be opened but in the presence of them all or their agents.

In goldsmiths' work, the counter-mark is the mark punched upon the work at the hall, to shew that the metal is standard. With horse-jockies, the counter-mark is an artful hole made in the teeth of old horses, to make them pass for horses of six years old. Counter-mark of a medal is a mark added to it a long time after its being struck. It is sometimes an Emperor's head, sometimes a cornucopia, &c. Countermarks are distinguished from the monograms in this, that being struck after the medal, they are indented; whereas the monograms being struck at the same time with the medals, have a little relievo.

Counter *paled*, in heraldry, is when the

escutcheon is divided into twelve pales parted *per fesse*, the two colours being counterchanged; so that the upper are of one colour, and the lower of another.

COUNTER *part*, in music, denotes one part to be applied to another. Thus the bass is said to be a counter-part to the treble. In law, it is the duplicate or copy of any indenture or deed.

COUNTER *passant*, is when two lions are in a coat of arms, and the one seems to go quite the contrary way from the other.

COUNTER *plea*, in law, a cross or contrary plea, particularly such as the demandant alleges against a tenant in courtesy, or dower, who prays the King's aid, &c. for his defence.

COUNTER *point*, in music, the art of composing harmony, or of disposing several parts in such a manner as to make an agreeable whole or a concert. In general, every harmonious composition, or composition of many parts, is called counter-point. It took its name from hence: before notes of different measures were invented, the manner of composing was to set pricks or points one against another, to denote the several concords.

COUNTER *pointed*, in heraldry, is when two chevrons in one escutcheon meet in the points, the one rising as usual from the base, and the other inverted falling from the chief; so that they are counter to one another in the points. They may also be counter-pointed when they are founded upon the sides of the shield, and the points meet that way, called counter-pointed in fesse.

COUNTER *poise* is a piece of metal, called by some the pear, on account of its figure, and the mass, by reason of its weight, which sliding along the beam, determines the weight of bodies weighed by the statera romana.

COUNTER *salient*, is when two beasts are borne in a coat leaping from each other directly the contrary way.

COUNTER *scarp*, in fortification, is properly the exterior talus or slop of the ditch; but it is often taken for the covered way and the glacis. In this sense we say, the enemy have lodged themselves on the counter-scarp.

COUNTERMAND, in the English law, is where a thing before executed is by some act or ceremony afterwards made void by the party that did it. A countermand may be either actual or implied: actual, where a power to execute any authority is, by a formal writing or deed for that purpose, put off for a time, or made void: implied, when a person makes his last will and testament, whereby he devises his land to such an one, and afterwards conveys the same land to another by feoffment.

COUNTY, in geography, originally signified the territory of a count or earl, but now it is used in the same sense with shire. See SHIRE.

England, for the better government thereof, and the more easy administration of justice, is divided into 52 counties, each whereof is subdivided into rapes, lathes, wapentakes, hundreds; and these again into tythings. For the execution of the laws in the several counties, excepting Cumberland, Westmoreland, and Durham, every Michaelmas term officers are appointed, called sheriffs: other officers of the several counties are lord lieutenants, custodes rotulorum, justices of the peace, bailiffs, high constables, coroner, clerks of the market, &c. Of the 52 counties in England and Wales, there are four termed counties palatine, *viz.* Lancaster, Chester, Durham, and Ely: these counties are reckoned among the superior courts, and are privileged as to pleas, so that no inhabitant of such counties shall be compelled by any writ to appear, or answer the same, except for error, and in cases of treason, &c. The counties-palatine of Durham and Chester are by prescription, where the King's writs ought not to come, but under the seal of the counties palatine, unless it be a writ of proclamation. There is a court of Chancery in the counties-palatine of Lancaster and Durham, over which there are chancellors. Scotland is divided into 33 counties, the government of which is committed to sheriffs.

COUNTY *corporate*, a title given to several cities on which the English monarchs have thought proper to bestow extraordinary privileges, annexing to them a particular territory of land, or jurisdiction, as the county of Middlesex annexed to the city of London, the county of the city of York, the county of the city of Bristol, &c.

COUNTY *court*, a court of justice, held every month in each county, by the sheriff or his deputy. See COURT.

COUP *de bride*, in the manege, the same with ebrillade. See EBRILLADE.

COUPED, in heraldry, is used to express the head or any limb of an animal, cut off from the trunk, smooth; distinguishing it from that which is called erassed, that

is, forcibly torn off, and therefore is ragged and uneven.

Couped is also used to signify such crosses, bars, bends, chevrons, &c. as do not touch the sides of the escutcheon, but are, as it were, cut off from them.

COUPLE *close*, in heraldry, the fourth part of a chevron, never borne but in pairs, except there be a chevron between them, saith Guillim, though Bloom gives an instance to the contrary.

COURSE, in navigation, that point of the compass or horizon on which the ship steers; or the angle between the rhumb-line and the meridian. See Navigation.

Course, in architecture, a continued range of stones, level, or of the same height throughout the whole length of a building, without being interrupted by any aperture.

Courses, in a ship, the mainsail and foresail: when the ship sails under them only, without lacing on any bonnets, she is then said to go under a pair of courses. To sail under a main course and bonnets, is to sail under a mainsail and bonnet.

COURSING, among sportsmen, is of three sorts, *viz.* at the deer, at the hare, and at the fox. These coursings are with greyhounds; for the deer there are two sorts of coursings, the one with the paddock, the other either in the forest or purlieu.

The best method of coursing the hare, is to go out and find a hare sitting, which is easily done in the summer by walking across the lands, either stubble, fallow, or corn grounds, and casting the eye up and down; for in summer they frequent those places for fear of the ticks, which are common in the woods at that season; and in autumn the rains falling from the trees offend them. The rest of the year there is more trouble required; as the bushes and thickets must be beat to rouse them, and oftentimes they will lie so close, that they will not stir till the pole almost touches them; the sportsmen are always pleased with this, as it promises a good course. If a hare lies near any close or covert, and with her head that way, it is always to be expected that she will take to that immediately on being put up; all the company are therefore to ride up, and put themselves between her and the covert before she is put up, that she may take the other way, and run upon open ground. When a hare is put up, it is always proper to give her ground, or law, as it is called; that is, to let her run twelve-score yards, or thereabouts, before the greyhounds are slipped at her; otherwise she is killed too soon, the greater part of the sport is thrown away, and the pleasure of observing the several turnings and windings that the creature will make to get away, is all lost. A good sportsman had rather see a hare save herself after a fair course, than see her murdered by the greyhounds as soon as she is up.

In coursing the fox, no other art is required, than standing close and in a clear wind, on the outside of some grove where it is expected he will come out; and when he is come out, he must have head enough allowed him, otherwise he will return back to the covert. The slowest greyhound will be able to overtake him, after all the odds of distance necessary; and the only danger is the spoiling the dog by the fox, which too frequently happens. For this reason, no greyhound of any value should be run at this course; but the strong, hard, bitter dogs that will seize any thing.

COURT, in a law sense, the place where judges distribute justice, or exercise jurisdiction; also the assembly of judges, jury, &c. in that place.

Courts are divided into superior and inferior, and into courts of record and base courts: again, courts are either such as are held in the King's name, as all the ordinary courts, or where the precepts are issued in the name of the judge, as the admiral's court.

The superior courts are those of the King's Bench, the Common Pleas, the Exchequer, and the Court of Chancery. A court of record, is that which has a power to hold plea, according to the course of the common law, of real, personal, and mixed actions; where the debt or damage is forty shillings, or above, as the court of King's Bench, &c.

A base court, or a court not of record, is where it cannot hold plea of debt, or damage, amounting to forty shillings, or where the proceedings are not according to the course of the common law, nor inrolled; such as the county-court, courts of hundreds, court-baron, &c.

The rolls of the superior courts of record are of such authority, as not to admit of any proof against them, they being only triable by themselves; but the proceedings of base courts may be denied, and tried by a jury. Some of the courts may fine, but not imprison a person, such as the leet; and some can neither fine nor inflict punishment, and can only amerce, as the county-court, court-

baron, &c. But the courts of record at Westminster Hall have power to fine, imprison, and amerce; and in those courts the plaintiff need not show, in his declaration, that the cause of action arises within their jurisdiction, being general; though, in inferior courts, it must be showed at large, on account they have particular jurisdictions.

COURT-BARON, a court that every lord of a manor has within his own precincts. This court must be held by prescription, and is of two kinds, *viz.* by common law, and by custom; the former is where the barons or freeholders, being suitors, are the judges; the other is, that where the lord or his steward is the judge.

COURT *of chivalry*, or the *marshal's court*, that whereof the judges are the lord high constable and the earl marshal of England. This court is the fountain of martial law, and the earl marshal is not only one of the judges, but is to see execution done. See CHIVALRY.

COURT *of conscience*, a court in the cities of London, Westminster, and some other places, that determines matters in all cases, where the debt or damage is under forty shillings.

COURT *of delegates*, a court where delegates are appointed by the King's commission, under the great seal, upon an appeal to him from the sentence of an archbishop, &c. in ecclesiastical causes, or of the court of admiralty, in any marine cause.

COURT *of hustings*, a court of record held at Guildhall, for the city of London, before the Lord Mayor and Aldermen, Sheriffs, and Recorder, where all pleas, real, personal, and mixed, are determined; where all lands, tenements, &c. within the said city, or its bounds, are pleadable in two hustings; the one called the hustings of plea of lands, and the other the hustings of common pleas. The court of hustings is the highest court within the city, in which writs of exigent may be taken out, and outlawries awarded, wherein judgment is given by the Recorder. To the Lord Mayor and city of London belong several other courts, as the court of Common Council, consisting of two houses, the one for the Lord Mayor and Aldermen, and the other for the commoners; in which court are made all by-laws, which bind the citizens. The Chamberlain's court relates to the rents and revenues of the city, to the affairs of servants, &c.

To the Lord Mayor belongs the court of coroner and escheator; another court for the conservation of the river of Thames; another of gaol delivery, held eight times a year at the Old Bailey, for the trial of criminals, where the Lord Mayor himself is the chief judge. There are also other courts called wardmotes or meetings of the wards; and courts of halymote, or assemblies of the guilds and fraternities.

COURT-LEET, a court ordained for the punishment of offences under high treason against the crown.

COURT-MARTIAL, a court appointed for the punishing offences in officers, soldiers, and sailors, the powers of which are regulated by the Mutiny Bill.

COURT *of Requests*, was a court of equity, of the same nature with the chancery, but inferior to it. It was chiefly instituted for the relief of such petitioners as in conscionable cases addressed themselves to his Majesty; the Lord Privy Seal was the chief judge of this court.

COURTESY, or CURTESY *of England*, a certain tenure whereby a man marrying an heiress seized of lands of fee simple, or fee tail general, or seized as heir of the tail special, and hath a child by her that cometh alive into the world, though both it and his wife die forthwith; yet if she were in possession, he shall keep the land during his life, and is called tenant per legem Angliæ, or tenant by the courtesy of England; because this privilege is not allowed in any country except Scotland, where it is called curialitas Scotiæ.

COUSIN, a term of relation between the children of brothers and sisters, who in the first generation are called cousin-germans, in the second generation, second cousins, &c.

Before the time of Theodosius, there was no law, ecclesiastical or civil, to prohibit the marriage of cousin-germans: under the reign of that emperor they were forbidden, but allowed again in the next reign, and under Justinian, who fixed the allowance in the body of his laws, but still the canons continued the prohibition, and extended it to a greater degree.

COUSU, in heraldry, signifies a piece of another colour or metal placed on the ordinary, as if it were sewed on, as the word imports. This is generally of colour upon colour, or metal upon metal, contrary to the general rule of heraldry.

COVERT, in heraldry, denotes something like a piece of hanging, or a pavilion

falling over the top of a chief or other ordinary, so as not to hide but only to be a covering to it.

COW, in zoology, the female of the ox-kind. See Bos.

CRAB'S *claws*. See MATERIA MEDICA.

CRAB'S *eyes*. See PHARMACY.

CRAB, an engine of wood, with three claws, placed on the ground like a capstan, and used at launching, or heaving ships into the dock.

CRADLE, in surgery, a case in which a broken leg is laid after being set.

CRADLE, among shipwrights, a timber frame made along the outside of a ship by the bilge, for the convenience of launching her with ease and safety.

CRAFT, in the sea-language, signifies all manner of nets, lines, hooks, &c. used in fishing. Hence all such little vessels as ketches, hoys, and smacks, &c. used in the fishing trade, are called small craft.

CRAMBE, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, Cruciformes. Essential character: filaments, the four longer, two-cleft at the end, one only of the tips bearing an anther; berry dry, globose, deciduous. There are six species, of which one is C. maritima, sea-colewort; the roots of this plant creep under ground, whereby it propagates very fast. The whole plant is smooth, glaucus, and sometimes tinged with purple; several stalks arise, about two feet high, spreading, much branched, bearing sessile leaves. The flowers or long peduncles are white. The fruit at first ovate, terminated by the blunt stigma, afterwards nearly spherical, the size of large peas. The young leaves, covered up with sand, and blanched, are boiled and eaten as a great delicacy. It is found on the sandy and beachy coasts of Sweden and Denmark; it is also common in many parts of England, particularly in the west.

CRAMP, in medicine, a convulsive contraction of a muscular part of the body, being either natural, as in convulsive constitutions, or accidental, from living in cold places, under ground, &c. It affects all parts indifferently, but the ham, calves, feet, and toes, oftener than the arms and hands.

An effectual preventative for cramp in the calves of the legs, which is a most grievous pain, is to stretch out the heel of the leg as far as possible, at the same time drawing up the toes to the body. This will frequently stop the progress of a fit of the cramp after it has commenced; and a person will, after a few times, be able in general to prevent the fit coming on, though its approach be between sleep and waking.

CRANE. See GRUS.

CRANE, in mechanics, a machine for raising goods into loft, or from vessels to wharfs, or for lowering them from heights, &c. in a safe manner, and by the application of a comparatively small power. Numberless contrivances have been resorted to for these purposes; the first of them appears to have been the great drum-wheel, in which one or more men, an ass, &c. being made to walk, a rotatory motion followed, whereby a rope fastened to the axis of the wheel was wound up, and with it whatever weight the power thus created was capable of lifting. But it was found that various fatal accidents attended this piece of machinery; for when the man slipped, the wheel would obtain a reverse motion, and by its accumulated velocity would dash him to pieces. On the other hand, if the rope suspending the weight gave way, the motion of the wheel, it being released from opposition, became so accelerated as to produce the same fatal effects.

An improvement upon this was the inclined plane, (seen in fig. 1, Pl. IV. Miscel.) which having ribs, or battens, all pointing to its centre, is moved by a man walking either nearer to or further from the axis, according to the weight to be raised, his greatest power being near the edge. The rope *x*, sustaining the weight *o*, passing through the pully *y*, and winding on the axis *p*, as it revolves in consequence of the man's pressure. To prevent accidents, the man has hold of the arm *n*, projecting from the post *z*; so that, in case of a slip, he might save himself by bearing thereon.

But though this plan is certainly a great improvement, yet it cannot be considered as altogether safe, and it takes up so much space, that it is very rarely in use. The windlass, worked by various different powers, and those varibusly applied, has in general superseded all other practices. It is to be lamented that some are too complex and expensive, which would otherwise prove highly serviceable. We give that in fig. 2, as being cheap and effective. It consists merely of a barrel, *e*, to which three concentric iron wheels, *a*, *b*, *c*, all graduated with equidistant teeth, and laying in one plane, secured also by cross bars, are affixed. The small wheel D having teeth fitting to those

on either wheel, may be brought forward to work in either *a*, *b*, or *c*, at pleasure. Now D being one foot in diameter, and *a* being two feet, the latter will revolve once, while the former revolves twice: this power is suited to light weights. When the resistance is greater, the power must be increased by removing D farther from the centre of the windlass *e*, and applying it to the second wheel *b*, which being three times the diameter of D, will turn only once while the latter makes three revolutions: again, when the weight is very great, D must be made to work upon the largest wheel *c*, which being four times its diameter, will cause D to turn four times while *c* turns but once. The figure is not exactly in the above proportions; but the explanation will suffice to render that minutia of less importance. D is turned by a crank-handle, or winch, and is made to fit into three different sockets, where its axis is keyed down opposite to whichever wheel is to be acted upon. It should have a small ratchet, or pall, to prevent its retrocession, in case the weight should overpower the operator.

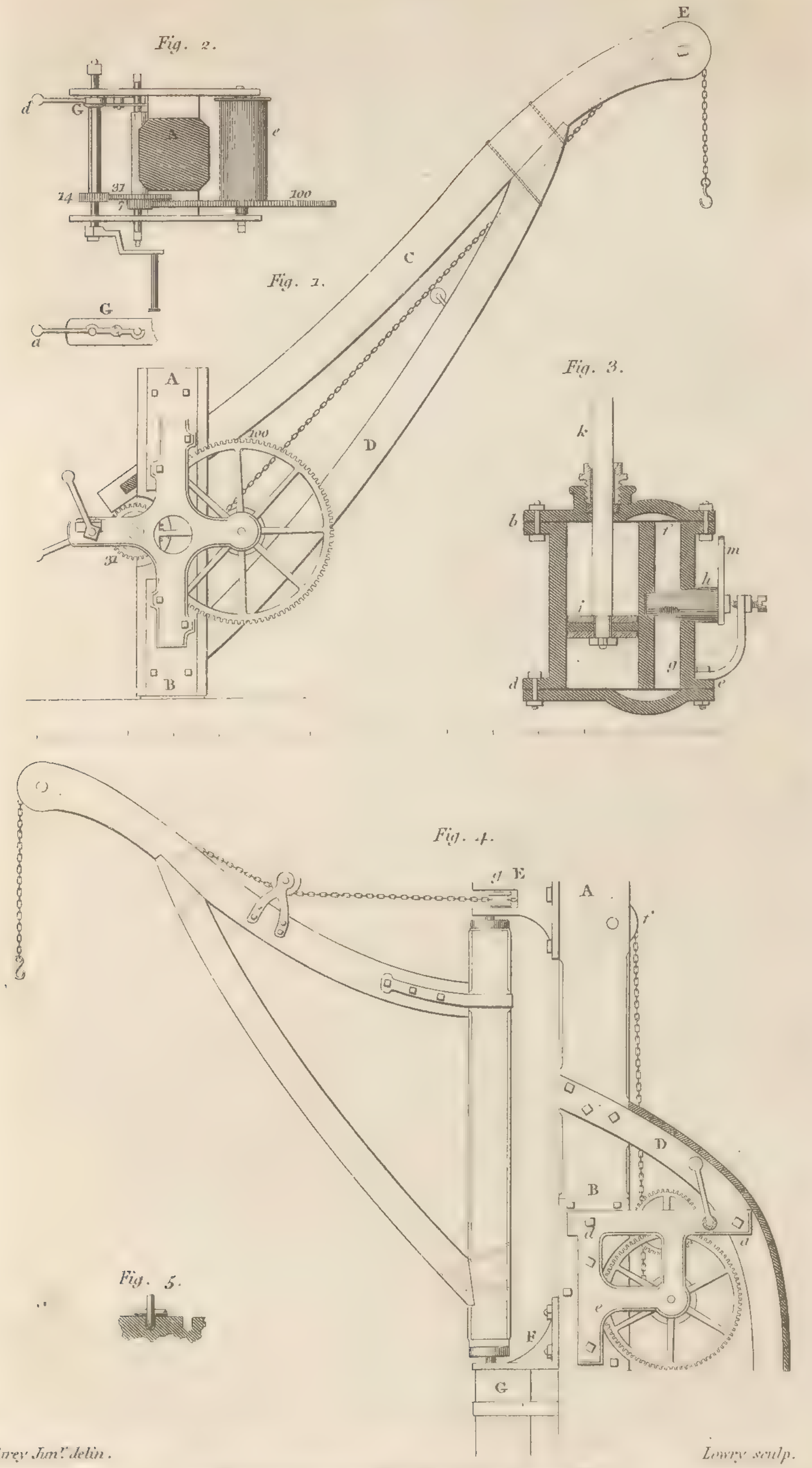
Some cranes are made to weigh goods as they are raised; but this can seldom be done with accuracy, though the general estimate may be correct enough for ordinary occasions. It is done by allowing the jib, or projection *m*, (fig. 2) to play on a joint at *n*, and by having a moveable weight at the other end of the beam, *s*, of which the jib forms a part, with an index, on the principle of the steel-yard. But this cannot answer where very heavy articles, such as cannon, &c. are to be raised, as the joints would soon give way. Whatever may be the construction of cranes, power and safety ought to be the principal objects.

We shall proceed to describe some other cranes that are much in use in the present day. Fig. 1, Plate Cranes, is an elevation of a crane sideways, and fig. 2 is a plan; A B is a stout beam, turning in a cast iron collar at B, affixed to beams in the floor of the wharf; it goes down about twelve feet below this, and has a steel pivot in the lower end, which works in a brass collar, so that the beam A B can turn round freely without shake; C D are the two beams of the jib, with a pully at E, over which the chain for hoisting the goods works; the other end of this chain is wound round a roll, *e*, 1 foot diameter; a cog wheel, marked 100, of 100 teeth, turned by a pinion of 7 leaves on the same axle with another wheel, 31, of 31 teeth; this is turned by a pinion, 14, of 14 teeth. If great power is required, the winch handle is applied to a square on the end of the spindle of the last pinion, and for less weight the winch is put on the axle of 31: when this is the case, the pinion 14 must be disengaged from its wheel, by sliding its axle lengthways. G is a clip to keep the pinion in or out of gear, as it has been placed by the attendant. A plan of it is also shewn in fig. 2: the two semicircular bands in it fit into grooves turned in the spindles, and the weight *a* at the end keeps them in: this prevents them moving endways: when the weight *a* is raised it releases them both; and when they are moved the clip fits into another groove turned in them, so as to prevent their return. The frame containing the wheels is formed by two cast-iron crosses, bolted to the main beam A B by the ends of their verticle arms, the two other arms forming the bearing for the wheels.

Cranes of this kind are now coming into very general use in London, as they require no expensive framing over them, and they can be turned all round. A further advantage they possess, in common with several other kinds, is the chain not being bent suddenly round the small pulleys over the jib when they are swinging overland, as in the common kind, and fig. 4.

A crane of this kind, which we saw at Woolwich Warren, had an apparatus (shewn in fig. 3) attached to it for lowering with safety great weights without any exertion of the workmen. It consists of a cylinder, *b d e*, of cast iron, smoothly bored through; *f g* is a passage connecting the top and bottom of the cylinder, and *h* a cock by which this passage can be closed: *i* is a piston fitting the cylinder, and *k* the rod affixed to it, moving through a stuffing box in the lid of the cylinder: the axis of the wheel 31 (fig. 1 and 2), or one in the place of it, has a crank on it working the piston rod of the cylinder (fig. 3), which is bolted fast to the back of the beam A B, with the usage sliding motion to render its motion parallel. The cylinder is filled full of oil, and as the handle of the crane is turned the piston is moved up and down in the cylinder: now, if the cock *h* is open the oil flows freely from one part of the cylinder to the other, without obstructing the motion of the crane; but if it is closed, the oil finding no other passage, and being an incompressible fluid, stops the piston and the descent of the goods suspended by the crane. By opening the cock partially the friction (or, as it

CRANES.



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Lowry sculp.

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is technically termed, the wire-drawing) of the oil impedes the motion of the wheels, so as to lower the greatest weights with any velocity required. A portion of the circle *m* is fastened to the cock, with fine teeth cut in it: a click takes into these teeth to hold the cock at any opening it may be set to. This contrivance is described in Gregory's Mechanics, published in 1806, applied to a different kind of crane, but the invention is ascribed to Mr. David Hardie. We consider it a contrivance of great utility, and likely to prove extremely useful.

Fig. 4 is an elevation of a crane at Queenhithe wharf, London. A B is a very strong upright beam, firmly bolted to beams running inland, and further secured by curved stays D: *a d e* is a cast-iron frame, bolted to the beam at one end, and the stays D at the other. This forms the frame for the wheelwork, which is the same as fig. 1; the chain, after going round the roll, goes over a large wheel *f*, and passes through the beam to the jib. E is a cast-iron frame, bolted to the top of the beam A B; to receive the upper pivot of the jib *g* is one of the small pulleys, round which the chain bends when the jib is turned overland to raise or lower goods. F is another cast-iron frame, to support the lower pivot of the jib, and G is a pile bolted to it to assist. A few boards nailed over the two stays D forms a cover for the whole machinery, and defends the wheel-work. The jib and its iron-work will be understood by inspection of the figure. All cranes where chains are used for hoisting the goods should have barrels, with a spiral groove cut in them, and the lower half of the chain lay in the groove, as in fig. 5. This was applied, in 1789, by Mr. John Smeaton to a crane designed by him, and executed at the Wool-quay, Custom-house, and found to be a great advantage. In 1805 Mr. Gilbert Gilpin received the Silver Medal of the Society of Arts for the same invention, without perhaps knowing it had been used before. The pulleys should also be grooved to receive the lower half of the links of the chain in the same manner.

CRANICHIS, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary galeated. There are five species, all natives of Jamaica.

CRANIOLARIA, in botany, a genus of the Didynamia Angeospermia class and order. Natural order of Personatæ. Bignoniæ, Jussieu. Essential character: calyx double of the flower; perianth four-leaved spathe one leaved; corolla tube very long; capsule of martynia. There is but one species, *viz.* C. annua, found in the neighbourhood of Carthagena in New Spain.

CRANIUM. See ANATOMY.

CRANK, a contrivance in machines, in manner of an elbow, only of a square form, projecting from a spindle, and serving by its rotation, to raise and fall the pistons of engines.

CRANK likewise denotes the iron support for a lantern, or the like; also the iron made fast to a stock of a bell for ringing it.

In the sea-language, a ship is said to be crank-sided when she can bear but small sail, for fear of over-setting; and when a ship cannot be brought on the ground without danger, she is said to be crank by the ground.

CRANZIA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five parted; petals five; nectary none; berried capsule. There is but one species, *viz.* C. aculeata, a prickly shrub; leaves ternate with pellucid dots; fruit dotted like the orange. Native of the East Indies.

CRAPE, in commerce, a kind of stuff made in the manner of gauze, with raw silk, gummed and twisted on the mill.

CRASPEDIA, in botany, a genus of the Syngenesia Polygamia Segregata. Essential character: calycle none; calyx imbricate; florets in depressed bundles, all hermaphrodite, tubular; down feathered; receptacle chaffy. One species, *viz.* C. uniflora, a native of New Zealand.

CRASSULA, in botany, a genus of the Pentandria Pentagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: calyx one leafed, five cleft; petals five; nectareous scales five at the base of the germ; capsule five, many-seeded. There are sixty-four species.

CRATÆGUS, in botany, a genus of the Icosandria Digynia class and order. Natural order of Pomacæ. Rosaceæ, Jussieu. Essential character: calyx five cleft; petals five; berry inferior, two seeded. There are twenty-three species. This genus consists chiefly of shrubs or trees, hardy and deciduous; leaves simple, undivided, or lobed; peduncles in most species many flowered; corymbed terminating, and solitary from the axils; corollas white, appearing in May and June, and succeeded by red berries in autumn.

CRATER, in astronomy, a constellation of the southern hemisphere. See Astronomy.

CRATEVA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Putamineæ. Capparides, Jussieu. Essential character: calyx four cleft; corolla three petalled; berry one-celled, many-seeded. There are five species. These are trees with ternate leaves, and the flowers in terminating panicles. Natives of both Indies.

CRAX, the curassow, in natural history, a genus of birds of the order Gallinæ. Generic character: bill strong, convex, and thick, the base of each mandible covered with a cere; nostrils small, and fixed in the cere; feathers which cover the head often curling at the ends; tail large and straight. Latham mentions four species, and Gmelin notices five. We shall select the C. alector, or the Peacock Pheasant of Guiana. These birds abound in the woods of Guiana, and are about the size of a small turkey, which they also extremely resemble in taste. They are destroyed by the Indians of the country in vast numbers, and sold to the planters, who are particularly fond of them, and with whom, as they are so plentiful, they constitute a frequent and almost daily article of food. They are easily domesticated, and found in this state, in great abundance, in the settlements of Berbice and Demerary, and in others of the West India islands. See Aves, Plate IV. fig. 7.

CRAYON, a name for all coloured stones, earths, or other minerals used in designing or painting in pastel. See Painting.

CREAM. See Milk.

Cream *of tartar*, the common name of supertartrate of potash; it is also denominated crystals of tartar. In this salt there is an excess of the Tartaric acid, which see.

CREDIT, in political economy, is the trust which an individual places in another individual, or in the state, in pecuniary transactions. This trust arises from a confidence in the creditor, that the debtor will fulfil the engagement into which he enters.

The foundation of credit is a knowledge of the circumstances of the debtor, or of his character for industry, ability, and probity. The degree of confidence is increased by experience of his punctuality in making good his engagements, and diminished by all circumstances which diminish the safety, or even interrupt the regular course of mercantile transactions.

The money-price of goods sold upon credit must be higher than that of goods paid for immediately, and this in proportion to the length of credit given and the risk. The advantage of giving credit to men of large capitals is that they get higher prices, the difference between the money-price and the credit-price being greater than the legal interest of the money-price for the time. Hence it is a principle with some traders to give very long credit at proportionate prices. The advantage to purchasers of small capital is, that these credits are so much addition to their capital for the time.

Some men of large property, but whose concerns admit of indefinite extension, will take all the credit they can get, either on pecuniary loans, or in purchases, being able to make a larger profit on any capital they can procure by either of these methods, than it costs them. They are exposed, however, 1, to the risk of having great demands made upon them when it may be inconvenient to satisfy them; and, 2, to the very common misfortune of forgetting how much of their capital belongs to other people: Dr. Franklin's observation being too true, that most men think their debt and their sins less than they really are. A person on whom credit is placed, and to whom it is advantageous, should be religiously punctual. Nothing will so much confirm his credit. He, however, is in a safer condition who can give credit without taking any; who sells on credit, but buys for money. And this should in general be the object of every young tradesman.

The degree of credit among private persons is considerably affected by the laws. If they tend to enforce the fulfilment of engagements, they strengthen credit; if they facilitate fraud, they enfeeble it.

The confidence placed in governments, on the public credit, depends exactly on the same causes as the credit of individuals, on the punctuality with which they fulfil their engagements. Hence in free states, i. e. states in which the creditors have a control over the government, credit is extensive; but in absolute monarchies it is little or nothing. It is an alarming circumstance for all creditors of the state, that wherein a great national debt has been contracted, the issue has been a national bankruptcy. The republics of Italy, and that of the United Provinces, as well as the monarchs of France, have ultimately discharged their debts in this unhappy manner. This has been caused, indeed, by the pres-

AVES Plate V.

Scott sc.

Fig. 1. **Colymbus** *glacialis: great northern diver* *Fig. 2.* C. *cristatus: great crested grebe.* *Fig. 3.* C. *rubricollis: red necked grebe* – *Fig. 4.* **Corvus** *corax: raven.* *Fig. 5.* C. *monedula. jackdaw* *Fig. 6.* C. *glandarius: jay* – *Fig. 7.* **Crax** *alector: crested curassow.*

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sure of inevitable circumstances, but it is not the less alarming on that account.

CREEPER, at sea, a sort of grapnel, but without flooks, used for recovering things that may be lost over-board.

CRENGLES, among seamen, small ropes spliced into the bolt-ropes of the sails of the main-mast and fore-mast, into which the bowling bridles are made fast.

CREPIS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ, Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled, with deciduous scales, down hairy, stipitate; receptacle naked. There are twenty species.

CREPITATION, in chemistry, the noise which some salts make over the fire during calcination, called also DECRIPITATION, which see.

CREPUSCULUM, *twilight*, the time from the first dawn or appearance of the morning, to the rising of the sun; and again, between the setting of the sun, and the last remains of day.

The crepusculum, or twilight, it is supposed, usually begins and ends when the sun is about 18 degrees below the horizon; for then the stars of the 6th magnitude disappear in the morning, and appear in the evening. It is of longer duration in the solstices than in the equinoxes, and longer in an oblique sphere than in a right one; because, in those cases, the sun, by the obliquity of his path, is longer in ascending through 18 degrees of altitude.

Twilight is occasioned by the sun's rays refracted in our atmosphere, and reflected from the particles of it to the eye. Kepler indeed assigned a different cause of the crepusculum, *viz.* the luminous matter about the sun. This may lengthen the duration of the twilight, by illuminating the air, when the sun is too low to reach it with his own light, but is not the principal cause of it: which is unquestionably the refraction of the atmosphere.

The depth of the sun below the horizon, at the beginning of the morning, or end of the evening twilight, is determined in the same manner as the arch of vision; *viz.* by observing the moment when the air first begins to shine in the morning, or ceases to shine in the evening; then finding the sun's place for that moment, and thence the time till his rising in the horizon, or from his setting in it in the evening. It is now generally agreed that this depth is about 18 degrees upon an average. Alhazen found it to be 19°; Tycho, 17°; Rothman, 24°; Stevenius, 18°; Cassini, 15°; Riccioli, in the equinox in the morning 16°, in the evening 20° 30′; in the summer solstice in the morning 21° 25′, in the winter solstice in the morning 17° 25′.

This difference among the determinations of astronomers is not be wondered at; the cause of the crepusculum being inconstant; for, if the exhalations in the atmosphere be either more copious or higher than ordinary, the morning twilight will begin sooner, and the evening hold longer than ordinary; for the more copious the exhalations are, the more rays will they reflect, consequently the more will they shine; and the higher they are, the sooner will they be illuminated by the sun. On this account too, the evening twilight is longer than the morning, at the same time of the year, in the same place. To this it may be added, that in a denser air the refraction is greater; and that not only the brightness of the atmosphere is variable, but also its height from the earth: and therefore the twilight is longer in hot weather than in cold, in summer than in winter, and also in hot countries than in cold, other circumstances being the same. But the chief differences are owing to the different situations of places upon the earth, or to the difference of the sun's place in the heavens. Thus, the twilight is longest in a parallel sphere, and shortest in a right sphere, and longer to places in an oblique sphere in proportion as they are nearer to one of the poles; a circumstance which affords relief to the inhabitants of the more northern countries, in their long winter nights. And the twilights are longest in all places of north latitude, when the sun is in the tropic of cancer; and to those in south latitude, when he is in the tropic of capricorn. The time of the shortest twilight is also different in different latitudes: in England, it is about the beginning of October and of March, when the sun is in the signs Libra and Pisces.

CRESCENT, in heraldry, a bearing in form of a new moon. It is used either as an honourable bearing, or as the difference to distinguish between elder and younger families; this being generally assigned to the second son, and those that descend from him. The figure of the crescent is the Turkish symbol, with its points looking towards the top of the chief, which is its most ordinary representation, called crescent montant. Crescents are said to be adossed, when their backs are turned to-

wards each other; a crescent is said to be inverted, when its points look towards the bottom; turned crescents have their points looking to the dexter-side of the shield; cornuted crescents to the sinister side; and affronted crescents, contrary to the adossed, have their points turned to each other.

CRESCENTIA, in botany, English calabash-tree, a genus of the Didynamia Angiospermia class and order. Natural order of Putamineæ. Solaneæ, Jussieu. Essential character: calyx two-parted, equal; corolla gibbous; berry pedicelled, one celled, many seeded; seeds two-celled. There are two species, *viz.* C. cujete, narrow leaved calabash-tree, and C. cucurbitina broad leaved calabash-tree. These are small trees, with large leaves, either singly, alternate, or in alternate bundles. Flowers on the trunk or branches sub-solitary; they are both natives of the West Indies.

CRESSA, in botany, a genus of the Pentandria Digynia class and order. Dubii, Linnæus. Convolvuli, Jussieu. Essential character: calyx five-leaved; corolla salver form; filaments sitting on the tube; capsule two-valved, one-seeded. There are two species, natives of the East Indies, in salt marshes.

CREST, in armoury, the top part of the armour for the head, mounting over the helmet, in manner of a comb, or tuft of a cock, deriving its name from crista, a cock's comb. The crest was for the most part made of feathers, or the hair of horses' tails or mains. The soldiers took great pride in adorning them. In most of the old monuments we find the crest represented, not much unlike those on the tops of our modern head-pieces: but whatever the common soldiers had, those of the officers were usually wrought in gold or silver, and the plumes of a larger size, quite across the helmet; and some wore two, three, or four together of these plumes.

Crest, in heraldry, the uppermost part of an armoury, or that part of the cask or helmet next to the mantle. Guillim says, the crest, or cognizance, claims the highest place, being seated on the most eminent part of the helmet; yet so as to admit of an interposition of some escrol, wreathe, chapeau, crown, &c. The crest is esteemed a greater mark of nobility, than the armoury, being borne at tournaments, to which none were admitted till such time as they had given proof of their nobility: sometimes it serves to distinguish the several branches of a family; and it has served, on occasion, as a distinguishing badge of factions: sometimes the crest is taken for the device; but more usually is formed of some piece of the arms. Families that exchange arms do not change their crest.

CREW, the company of sailors belonging to a ship, boat, or other vessel. The sailors that are to work and manage a ship, are regulated by the number of lasts it may carry, each last making two tun.

CRIBBAGE, a game at cards, wherein no cards are to be thrown out, and the set to make sixty-one; and as it is an advantage to deal, by reason of the crib, it is proper to lift for it, and he that has the least card deals.

There are only two players at this game, wherein the cards are dealt out one by one, the first to the dealer's antagonist, and the next to himself; and so on, till each have five: the rest being set down in view on the table.

This done, the dealer lays down the two best cards he can for his crib; and his antagonist lays down the other two, the very worst in his hand, by reason the crib is the property of the dealer. They next turn up a card from the parcel left after dealing, and then count their game thus: any fifteen upon the cards is two; as king and five, ten and five, nine and six, eight and seven, &c. A pair is also two; a pair royal, or three aces, kings, &c. six; a double pair royal, or four aces, &c. twelve. Sequences of three cards, as, four, five, and six, is three; sequences of four, four; five, five, &c. and the same holds of a flush. Knave noddy, or of the suit turned up, is one in hand, and two to the dealer. If, after the cards for the crib are laid out, you have in your hand a nine and two sixes, that makes six; because there is two fifteens, and a pair: and if a six chance to be turned up, then you have twelve in your hand, *viz.* the pair royal, and three fifteens. These are to be marked with pegs, counters, or otherwise. If you happen to have sequences, as of four, five, and six in your hand, and six be the turned up card, they are counted thus: first, the sequences in your hand make three; and the sequences of the four and five in your hand, added to the six turned up, make other three: there is likewise two fifteens, counting first with the six in your hand, and then with that turned up.

This done, the antagonist to the dealer plays first, suppose a six; and if the dealer can make it fifteen, by playing nine, he

gains two; and he that reaches thirty-one exactly gains two, or comes nearest under it, gains one. Here too, in playing of the cards, you may make pairs, pairs-royal, flushes, &c. which are all counted as above.

As to the crib, it is the dealer's, who may make as many as he can out of them, together with the card turned up; counting as above: if he can make none, he is said to be bilked.

Thus they play and deal by turns, till the game of sixty-one is up; and if either of the gamesters reach this before the other is forty-five, this last is said to be lurched, and the other gains a double game.

CRIBRARIA, in botany, a genus of the Cryptogamia Fungi: case furnished with a double membrane, the outer one thin and fugacious, inner one reticulate; seeds without filaments, ejected through the foramina. One species, *viz.* the pallida.

CRICKET, the name of an exercise or game with bats and balls. The laws of this game, as settled by the cricket club in 1744, and played at the Artillery-ground, London, are as follow. The pitching the first wicket is to be determined by the cast of a piece of money. When the first wicket is pitched, and the popping-crease cut, which must be exactly three feet ten inches from the wicket, the other wicket is to be pitched directly opposite at twenty-two yards distance, and the other popping-crease cut three feet ten inches before it. The bowling-creases must be cut in a direct line from each stump. The stumps must be twenty-two inches long, and the bail six inches. The ball must weigh between five and six ounces. When the wickets are both pitched, and all the creases cut, the party that wins the toss up may order which side shall go in first, at his option.

The laws for the bowlers. Four balls and over.—The bowler must deliver the ball with one foot behind the crease, even with the wicket, and when he has bowled one ball, or more, shall bowl to the number four before he changes wickets; and he shall change but once in the same innings. He may order the player that is in at his wicket to stand on which side of it he pleases at a reasonable distance. If he delivers the ball with his hinder foot over the bowling-crease, the umpire shall call no ball, though she be struck, or the player is bowled out, which he shall do without being asked, and no person shall have any right to ask him.

Laws for the strikers, or those that are in.—If the wicket is bowled down, it is out. If he strikes or treads down, or he falls himself upon the wicket in striking, but not in over-running, it is out. A stroke or nip over or under his bat, or upon his hands, but not arms, if the ball be held before she touches ground, though she be hugged to the body, it is out. If in striking, both his feet are over the popping-crease, and his wicket put down, except his bat is down within, it is out. If he runs out of his ground to hinder a catch, it is out. If a ball is nipped up, and he strikes her again wilfully before she come to the wicket, it is out. If the players have crossed each other, he that runs for the wicket that is put down, is out: if they are not crossed, he that returns is out. If in running a notch, the wicket is struck down by a throw before his foot, hand, or bat is over the popping-crease, or a stump hit by the ball, though the bail was down, it is out. But if the bail is down before, he that catches the ball must strike a stump out of the ground-ball in hand, then it is out. If the striker touches or takes up the ball before she is lain quite still, unless asked by the bowler or wicket-keeper, it is out.

Bat, foot, or hand over the crease.—When the ball has been in hand by one of the keepers or stoppers, and the player has been at home, he may go where he pleases till the next ball is bowled. If either of the strikers is crossed in his running ground designedly, which design must be determined by the umpires, the umpires may order that notch to be scored. When the ball is hit up, either of the strikers may hinder the catch in his running ground, or if she is hit directly across the wickets, the other player may place his body any where within the swing of the bat, so as to hinder the bowler from catching her: but, he must neither strike at her, nor touch her with his hands. If a striker nips a ball up just before him, he may fall before his wicket, or pop down his bat before she comes to it, to save it. The bail hanging on one stump, though the ball hit the wicket, it is not out.

Laws for the wicket-keepers.—The wicket-keeper shall stand at a reasonable distance behind the wicket, and shall not move till the ball is out of the bowler's hand, and shall not by any noise incommode the striker; and if his hands, knees, foot, or head be over, or before the wicket, though the ball hit it, it shall not be out.

Laws for the umpires.—To allow two

minutes for each man to come in when one is out, and ten minutes between each hand. To mark the ball that it may not be changed. They are sole judges of all outs and ins, of all fair or unfair play, of all frivolous delays, of all hurts, whether real or pretended, and are discretionally to allow what time they think proper before the game goes on again. In case of a real hurt to a striker they are to allow another to remain, and the person hurt to come in again; but are not to allow a fresh man to play on either side on any account. They are sole judges of all hindrances, crossing the players in running, and standing unfair to strike; and, in case of hindrance, may order a notch to be scored. They are not to order any man out unless appealed to by one of the players. Those laws are to the umpires jointly.

Each umpire is the sole judge of all nips and catches, ins and outs, good or bad runs, at his own wicket, and his determination shall be absolute, and he shall not be changed for another umpire without the consent of both sides. When the four balls are bowled, he is to call over. These laws are separately.

When both umpires call play three times it is at the peril of giving the game from them that refuse to play.

CRIME, the transgression of a law, either natural or divine, civil or ecclesiastic.

Civilians distinguish between crimen and delictum. By the first they mean capital offences injurious to the whole community, as murder, perjury, &c. the prosecution of which was permitted to all persons, though no ways immediately interested. By the latter they understand private offences committed against individuals, as theft, &c. By the laws, no body was allowed to prosecute in these, except those interested.

With us crimes are distinguished into capital, as treason, murder, robbery, &c. and common, as perjuries, &c. Again, some crimes are cognizable by the king's judges, as the above-mentioned; and others are only cognizable in the spiritual courts, as simple fornication.

CRIMNOIDES, or CRIMOIDES, among physicians, a term sometimes used for the sediment of urine, resembling bran.

CRIMSON, one of the seven red colours of the dyers. See DYEING.

CRINODENDRUM, in botany, a genus of the Monadelphia Decandria class and order. Essential character: calyx none; corolla bell-shaped, six-petalled; capsule one-celled, gaping elastically at top. There is but one species, *viz.* C. patagua, a beautiful evergreen branchy tree, with a body seven feet in diameter. It is a native of Chili.

CRINUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: corolla funnel-form, monopetalous, six-parted, three alternate segments unciate; germ at the bottom of the corolla, covered; stamina distant. There are six species.

CRITHMUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit oval, compressed; florets equal. There are three species.

CRITICISM, from the Greek word κρινω, signifies, in general, the art of judging: but, in its more restrained and usual sense, denotes the art of judging with propriety concerning the nature of literary compositions.

Notwithstanding the ignorance and insolence which have occasionally disgraced the writings of professed critics of minor rank, and notwithstanding the sneers of one of the wittiest of English authors against what he denominates the "cant of criticism," and his memorable eulogium of those who "are pleased they know not why, and care not wherefore," the art of criticism is founded in nature, and every man of thinking mind is led to the practice of that art. The merits or demerits of literary works are a perpetual subject of comment, and the intelligent reader is not contented with referring to his own immediate feelings as the grounds of his verdict, but appeals to certain principles which he regards as established, and which he quotes as the guides of opinion. When, after we have perused a poem, or attended at the representation of a play, we call to mind what has pleased and what has displeased us in the whole, or in the parts of it, we exercise criticism in its simplest form; but when at the call of a laudable curiosity, or in order to enable ourselves to detail the reasons of our admiration or of our disappointment, we attentively examine those reasons, we rise into the regions of philosophy; and the principles which are founded on the basis of philosophy can alone constitute the standard of true taste.

If these principles be the rules by which the intelligent reader forms his decision upon the character of an author's writings, it is evident that the writer who would wish

to please the intelligent must conform himself to the laws which are established by their sanction. It is true, indeed, that the promulgation of the rules of criticism did not precede the production of some of the greatest monuments of human genius. On the contrary, the circulation of works of transcendent merit afforded the models, from the contemplation of which were derived the rules of criticism. It was from the study of Homer, of Eschylus, of Sophocles, and Euripedes, that Aristotle deduced those laws of composition which have been universally received, by the enlightened part of the world, as the dictates of sound judgment and elegant discrimination. But it must not on that account be imagined, that the authors of those models did not form and shape them by rule. Though they were not guided by any *lex scripta*, it may truly be asserted, that "they were a law unto themselves;" they were guided by an intuitive sense

> "Of decent and sublime, with quick
> disgust
> Of things deform'd, or disarrang'd, or
> gross
> In species ———"

But as this immediate perception of what is fitting and what is unbecoming in works of art, seems to be communicated only to a chosen few, it must be regarded as a law of our nature, that mankind in general must be content to learn by study, what they do not derive from intuition, and on this circumstance are founded the utility and the dignity of the elements of criticism.

The truth of this observation will be the more apparent, if we examine the writings of those, who either enjoyed no opportunity of becoming acquainted with those elements, or from the heights of their vain imaginations looked down upon them with contempt. These have universally been betrayed into the most glaring improprieties, which, though they may in some instances have been, by the applause of the injudicious, rendered popular for a short period, have never stood the test of time, but in consequence of the operation of good sense have been finally condemned by the unanimous suffrage of the public. The conceits of Cowley had their admirers for a few years, but they are now buried in oblivion, or are only quoted as lessons of warning to the youthful poet. It is the opinion of true judges, which rectifies the impressions of the multitude when they are led astray by haste, by ignorance, or by the pursuit of false ornament, that at length bestows the meed of lasting renown.

Let it not be said, in opposition to this recommendation of the study of the rules of criticism, that certain writings, which have grossly violated their precepts, have nevertheless descended with high applause to future times, and are still read with unabating avidity. This may be true: and indeed in the deserved popularity of the plays of Shakspeare, we have in our vernacular language a most striking case in point. But it has been justly observed, that these plays "have gained the public admiration, not by their being irregular, not by their transgressions of the rules of art, but in spite of such transgressions. They possess other beauties, which are conformable to just rule; and the force of these beauties has been so great as to overpower all censure, and to give the public a degree of satisfaction superior to the disgust arising from their blemishes." If the mixed metaphors, the low puns, and far-fetched allusions which abound in Shakspeare's writings had not been redeemed by such truly empassioned and high-wrought scenes as the closet interview between Hamlet and his mother, or the terrific phantom of the "air-drawn dagger," his works would have been left to moulder in the dust of public libraries, or would have been doomed by their rare occurrence to acquire a factitious value, by being stored up on the shelves of the curious collector.

If rightly considered, indeed, the instance of Shakspeare eminently evinces the necessity of an acquaintance with the rules of criticism, to the attainment of perfection in the art of composition. Had that child of fancy possessed taste in the same degree with which he was gifted with genius, he would have reduced the plots of his dramas to order; he would have pruned the luxuriance of his style; he would have discarded all meretricious ornaments, and would have cleared away those incongruities which abound in his writings, like noisome and disgusting weeds amidst a wilderness of sweets. Thus would he have risen from the rank of the darling of a nation, to that of the poet of the civilized world. Whilst it must be confessed that the most approved system of rules cannot kindle the fire of genius, or stimulate the activity of the imagination; yet it is equally true that a knowledge of the laws of criticism is absolutely necessary to preserve a writer from

committing egregious faults. Justly has it been observed by Horace, that the author who wishes to excel

"*Cum tabulis animum censoris sumet honesti.*"

And for the direction of his judgment he can take no guide so sure as those principles which have been sanctioned by the approbation of enlightened ages as the laws of just taste.

To enter into a regular detail of the objects embraced in a system of the rules of criticism, would be inconsistent with the design of the present work; but a short enumeration of the principal writers on the subject may not be altogether useless.

Aristotle is the great father of the critic art; and his treatises on Poetry and Rhetoric exhibit the fundamental principles on which that art is built. His style is compressed and abrupt; and his language is so devoid of the attractions of ornament, that, as a celebrated French scholar has justly observed, "in order to be able to read his works, a person must be fully bent upon obtaining instruction." The dryness of his manner, however, is amply compensated by the perspicuity of his arrangement, the ingenuity of his disquisitions, and the profundity of his thoughts. Many useful observations on the general principles of composition, are to be found in Cicero's treatises on the subject of oratory; and the Institutes of Quintilian also contain a rich mine of criticism. Much useful instruction may also be gained from the critical dissertations, which occasionally occur, in the Satires and Epistles of Horace, and especially in his Epistle to the Pises on the art of Poetry. Longinus's work on the Sublime, though occasionally deficient in precision, is written with singular energy and spirit, and evinces a feeling mind, the emotions of which are regulated by exquisite taste.

The spirit of Horace was infused into Boileau, who, of all the French critics, was the most delicate in judgment; though much praise is also due to the critical works of Rapin, Bossu, and Bonhours. Rollin's treatise on the Belles Lettres is a book of great value; and in our own days, the seeds of good taste have been widely scattered through the continent of Europe by the publication of La Harpe's Lycée.

The English language is rich in critical disquisitions, of which many excellent ones are to be found in the prefaces prefixed by Dryden to his multifarious productions. In his "Advice to an Author," Lord Shaftesbury has well asserted the dignity and importance of the art of criticism, and has detailed, in measured and elevated style, the principles of fine writing, which he had collected from the study of the ancients. Pope's Essay on Criticism is too well known to stand in need of commendation; and the critique of Addison on the Paradise Lost, is perused with interest by every Englishman of cultivated mind. At a more modern period, Mr. Harris, in his Philological Enquiries, has exhibited the substance of the writings of Aristotle; and Dr. Johnson, in his Observations upon the works of the English Poets, has, notwithstanding the occasional aberrations into which he was betrayed by prejudice, given decisive proofs of a superior intellect. Ward's Treatise on Oratory, Priestley's Lectures on Oratory and Criticism, and Kaimes's Elements of Criticism, respectively contain systems of considerable merit. But the standard book on this subject is Blair's Lectures on Belles Lettres. Blair was a scholar and a philosopher; and his work only wants a portion of the spirit of enthusiasm to render them a complete model of didactic composition.

CRITICISM, *verbal*, is the art of settling with probability, or, as a practitioner of that art would say, with precision, the text of the ancient Greek and Latin classic authors. This species of criticism takes its rise from the state in which the writings of those authors have come down to modern times. The art of printing being unknown at the period when they were composed, they were preserved by transcription; from which circumstance they were evidently liable to be deformed by errors, and those errors must necessarily have been greatly multiplied by the lapse of ages. A passage in Aulus Gellius, which states, that a reading in Cicero was justified by a copy made by his learned freedman Tyro; and a reading in Virgil's Georgics, by a book which had formerly belonged to Virgil's family, at once demonstrates the early corruption of works of taste, and the early stress which was laid upon the authority of ancient manuscripts.

In the long night of ignorance, which succeeded the subversion of the Roman empire by the barbarians of the north, the classic authors were forgotten, and their works were neglected, and left to perish. But when literature revived in Italy, they became the objects of the most eager and di-

ligent research. In the fifteenth and sixteenth centuries, the discovery of an ancient Greek or Latin manuscript was celebrated as an event of the greatest importance, and gave occasion to the most enthusiastic exultation. The difficulty of perusal, however, which was experienced in some instances, called into exercise the skill of the most practised scholars; and the real or supposed corruptions of the text in most of the *codices* which were at this period brought to light, afforded a copious subject for the acumen of the ablest critics. The letters of Ambrogio Traversari, of Leonardo Aretivo, and of Poggio Bracciolini, abundantly prove, that emendation was one of the first duties of the fortunate man of letters, who had rescued a classic author from oblivion. There is too much fear that this duty was not in every instance discharged with the requisite ability and discretion—but, however this may be, the copies which were multiplied by the hands or under the inspection of the revivers of literature, are at this day almost the sole authority, to which the learned can refer, in settling the text of the compositions of the most distinguished writers of Greece and Rome.

The invention of the art of printing was, as might naturally be expected, soon employed in multiplying copies of the ancient classics, the impressions of which were carefully superintended by the great luminaries of the age. Among these shine with preeminent lustre Politian, Landino, and Marcus Musurus, who, by the collation of MSS. and the application of temperate conjecture, endeavoured to exhibit the works of the classic writers in their purity. But of all these friends and promoters of good literature, the place of most distinguished honour, is due to Aldus Manutius. This illustrious scholar, by his fame, and by his munificence, attracted to Venice, the place of his residence, the ornaments of the literary world, by whose assistance, in the examination of MSS. and in the other duties of an editor, he was enabled to publish copious editions of almost every Greek and Latin classic, which may be yet regarded as unrivalled in elegance and correctness. From his time to the present day, may be traced a succession of scholars, who have endeavoured, with various success, to evince their learning and their acumen by their emendations of the text of the ancient classics; and whosoever has studied with due attention the lucubrations of a Heyne or a Porson, will readily acknowledge, that even at this late period, a rich harvest may be gathered in the field of verbal criticism.

It is much to be lamented, however, that the art of verbal criticism has been brought into discredit, by the rashness of certain editors of the ancient classics; who, inspired with the rage of innovation, have despised the authority of manuscripts, and have deformed the finest models of antiquity by the introduction of their own crude fancies, under the form of conjectural emendation. It has been well observed, that by such critics as these, "authors have been taken in hand, like anatomical subjects, only to display the skill and abilities of the artist; so that the end of many an edition seems often to have been no more, than to exhibit the great sagacity and erudition of an editor. The joy of the task, was the honour of amending, while corruptions were sought with a more than common attention, as each of those afforded a testimony to the editor and his art." The gross impropriety of this pruriency of alteration is well displayed in the Virgilius Restauratus, which is usually printed with the works of Pope, and which, though expressly intended to ridicule the proud presumption of Bentley, may be regarded as an anticipated specimen of the lucubrations of certain critics, who have flourished in more modern times.

Nearly allied to verbal criticism is, Illustrative Criticism, or the art of explaining the ancient classic authors. This art gave rise to the tribe of scholiasts and commentators. Of these, some restricted themselves to the illustration of particular authors, and others exercised their talents upon a selection of passages from a variety of writers. Among the former may be mentioned Didymus and Eustathius, who bestowed their labours upon Homer; and among the latter may be classed Politian, whose Miscellanea contains a copious fund of erudition. The modern writers of these two classes, under the denomination of editors, commentators, and translators, are in a manner innumerable.

CROCODILE. See Lacerta.

Crocodile, *fossil*, one of the greatest curiosities in the fossil world which the late ages have produced. It is the skeleton of a large crocodile, almost entire, found at a great depth under ground bedded in stone. This was in the possession of Linkius, who wrote many pieces in natural history, and particularly an accurate descrip-

tion of this curious fossil. It was found in the side of a large mountain in the midland part of Germany, and in a stratum of black fossil stone, somewhat like our common slate, but of a coarser texture, the same with that in which the fossil fishes in many parts of the world are found. This skeleton had the back and ribs very plain, and was of a much deeper black than the rest of the stone; as is also the case in the fossil fishes which are preserved in this manner. The part of the stone where the head lay was not found; this being broken off just at the shoulders, but that irregularly; so that in one place a part of the back of the head was visible in its natural form. The two shoulder-bones were very fair, and three of the feet were well preserved: the legs were of their natural shape and size: and the feet preserved even to the extremities of the five toes of each.

CROCUS, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-parted, equal; stigmas convolute. There are two species with many varieties, *viz.* C. officinalis, officinal crocus, or saffron, and C. vernus, or spring crocus.

CROISADE, CRUSADE, or CRUZADO, a name given to the expeditions of the Christians against the Infidels, for the conquest of Palestine; so called because those who engaged in the undertaking wore a cross on their clothes, and bore one on their standard. This expedition was also called the holy war, to which people flocked in great numbers out of pure devotion, the pope's bulls and the preaching of the priests of those days making it a point of conscience. The several nations engaged in the holy war were distinguished by the different colours of their crosses: the English wore white, the French red, the Flemish green, the Germans black, and the Italians yellow. From this enterprise several orders of kighthood took their rise. They reckon eight croisades for the conquest of the Holy Land: the first begun in the year 1095, at the solicitation of the Greek Emperor and the Patriarch of Jerusalem.

CROMLECH, in British antiquities, are huge broad flat stones, raised upon other stones set up on end for that purpose. They are common in Anglesea. They are supposed by some persons to have been tombs, though others imagine that they were altars for religious services.

CROSIER, or CROZIER, a shepherd's crook; a symbol of pastoral authority, consisting of a gold or silver staff crooked at the top, carried occasionally before bishops and abbots, and held in the hand when they give the solemn benedictions. The custom of bearing a pastoral staff before bishops is very ancient. Regular abbots are allowed to officiate with a mitre and crosier. Among the Greeks none but a patriarch had a right to the crosier.

CROSIER, in astronomy, four stars in the southern hemisphere in the form of a cross, serving those who sail in south latitudes to find the antarctic pole.

CROSS, in heraldry, is defined by Guillim, an ordinary composed of fourfold lines, whereof two are perpendicular, and the other two transverse; for so we must conceive of them, though they are not drawn throughout, but meet, by couples, in four right angles near about the fesse-point of the escutcheon. The content of a cross is not always the same; for when it is not charged, it has only the fifth part of the field; but if it be charged then it must contain the third part thereof. This bearing was bestowed on such as had performed, or, at least, undertaken some service for Christ and the Christian profession; and is therefore held by several authors the most honourable charge in all heraldry. What brought it into such frequent use was the ancient expeditions into the Holy Land, the cross being the ensigns of that war.

CROSSOSTYLIS, in botany, a genus of the Monadelphia Polyandria class and order. Essential character: calyx simple, four-parted; corolla four-petalled; nectary twenty, corpuscles between the filaments; stigmas four-jagged. There is but one species, *viz.* C. biflora, a native of the Society Isles.

CROSSELET, a little or diminutive cross, used in heraldry, where the shield is frequently seen covered with crosselets; also fesses and other honourable ordinaries, charged or accompanied with crosselets. Crosses frequently terminate in crosselets.

CROTALARIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ, Jussieu. Essential character: legume turgid, inflated, pedicelled; filaments connate, with a fissure on the back. There are thirty-two species, all natives of warm climates.

CROUTE, *sour croute.* As this preparation of cabbage has been found of sovereign efficacy as a preservative in long voyages

from the sea-scurvy; it may not be unacceptable to give a concise account of the process for making it, according to the information communicated by an ingenious German gentleman. The soundest and most solid cabbages are selected for this use, and cut very small, commonly with an instrument made for this purpose, not unlike the plane which is used in this country for slicing cucumbers. A knife is used when the preparation is made with great nicety. The cabbage thus minced is put into a barrel in layers, hand high, and over each is strewed a handful of salt and carraway seeds; in this manner it is rammed down with a rammer, *stratum super stratum*, till the barrel be full; when a cover is put over it and pressed down with a heavy weight. After standing sometime in this state it begins to ferment; and it is not till the fermentation has entirely subsided that the head is fitted to it, and the barrel is finally shut up and preserved for use.

CROTALUS, the *rattlesnake*, in natural history, a genus of Amphibia, of the order Serpentes. Generic character: scuta on the abdomen; scuta and scales beneath the tail; rattle at the end of the tail. There are five species. The C. horridus, or banded rattle-snake, inhabits Carolina in North America, and is from three to five feet in length, of a yellowish brown colour. The rattle is fixed at the end of the tail, and is composed of dry and hollow bones, nearly of the same form and size. The tip of every bone superior to the two last, passes within the two immediately beneath it, thus producing a firm coherence, and also an increase of noise, as during the sounding of the rattle each bone strikes against two others. The object of this curious instrument has not a little perplexed naturalists, and some have considered it designed to warn other animals of their danger, while others have regarded it as intended, indeed, to sound the alarm of peril, but such an alarm as is followed by consternation, under which the affrighted victims experience a prostration of all its faculties, and is bereaved at once of intelligence and motion. These animals were supposed to possess the power of charming others, or of operating upon them by some ineffable power, to induce them to drop from their stations into the very mouth of the destroyer. This opinion, long prevailing, but now exploded, not unnaturally arose from the circumstance just mentioned. The appearance of the rattle-snake to these creatures, who instantly recognize it for their mortal enemy, and the sound of that instrument, which is as it were the signal of execution, impresses them occasionally with a degree of terror, which withers all the energies of their frame, and relaxing their hold on the branches of trees, causes them to drop almost lifeless into the mouth of their adversary. These animals have been known to enter houses in America, and even to insinuate themselves into beds. They move with great slowness; and with respect to all other animals but those which they subsist on, never inflict any injury but in retaliation, wounding on provocation and not in aggression. Their bite is not only poisonous, but rapidly fatal, and has been known to kill a man in two minutes. When the bite is received in a fleshy part, the Indians apply the knife with all possible speed. In slight cases they have recourse to various roots; and in some cases they suck the wound: but when a principal vein or artery is penetrated, with the animal's full strength, they abandon their case as hopeless, and apply no remedy whatever. In the territories of America, but thinly inhabited, rattle-snakes are abundant; but in others they are almost exterminated. They are seldom seen farther north than Lake Champlain, or south than Brazil. They are extremely fond of frogs, and are found generally where these are most to be met with. In summer they are generally seen in pairs; in winter they are gregarious, and secure themselves from the rigours of the season by withdrawing deeply in the earth, whence a fine day sometimes induces them to appear, but in a state of great weakness, in which they may be attacked without danger, and in which a single person has sometimes destroyed with a stick several score in a single morning. The largest ever seen by Catesby, who, while in Carolina, paid particular attention to them, was about eight feet long, and nearly nine pounds in weight. It is mentioned by Dr. Shaw, from Bouvais, that this snake, which is viviparous, possesses the mode of securing its young ascribed to the European viper, of swallowing them during the period of danger, and disgorging them after it is over. Mr. Bouvais having inadvertently molested a rattle-snake in his walk, saw the animal instantly coil itself up, and distend its jaws, into which five young ones rushed with great rapidity. He watched it for about a quarter of an hour, at the end of which time he saw them thrown up. To remove the pos-

possibility of deception, he then re-approached, and saw the parent open the same asylum, and the offspring avail themselves of it with the same celerity; after which the snake moved beyond his observation. From experiments made on various dogs by the bite of this snake, one was killed in a quarter of a minute; another, bitten afterwards, in two hours; and a third, bitten last, in above three. It was a matter of natural curiosity to ascertain whether the animal would destroy itself by its bite, and, being provoked by some means to inflict on itself a wound, it expired in about twelve minutes afterwards.

CROTCHES, in ship-building, very crooked timbers in the hold or bread-room, from the mizen-step aft, fayed cross the keelson, to strengthen the ship in the wake of the half timbers.

CROTCHET, in music, one of the notes or characters of time, marked thus 𝅘𝅥, equal to half a minim, and double of a quaver.

CROTCHET, in printing, a sort of straight or curved line, always turned up at each extreme; serving to link such articles as are to be read together; and used in analytical tables, &c. for facilitating the divisions and subdivisions of any subject.

CROTCHETS are also marks or characters, serving to inclose a word or sentence, which is distinguished from the rest, being generally in this form [ ] or this ( ).

CROTON, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoceæ. Euphorbiæ, Jussieu. Essential character: male, calyx cylindric, five-toothed; corolla five-petalled; stamens ten to fifteen: female, calyx many-leaved; corolla none; styles three, bifid; capsule three-celled; seed one. There are 53 species. The plants of this numerous genus are herbaceous, or more frequently shrubby. Leaves accompanied with stipules, generally alternate, seldom opposite: flowers axillary, or terminating usually in spikes; but sometimes in corymbs: the spikes are mostly monaecous. These plants are chiefly inhabitants of the East and West Indies.

CROTOPHAGI, the *ani*, in natural history, a genus of birds of the order Picæ. Generic character: bill compressed, semi-oval, arched and cultrated at the top; nostrils round; tongue flat, pointed at the end; tail of ten feathers; toes two before and two behind. There are four species; the principal of which is the C. ani, or the lesser ani. These are found in many parts of the West Indies and South America, and are about the size of a blackbird. A curious peculiarity connected with the history of these birds is, that many females will unite in the construction of one nest, where each will deposit a certain number of eggs, and contribute her part to the general process of incubation. Each will also contribute after the young are hatched to provide, as far as her means extend, for the whole family. As soon as she has laid her eggs, the female has been remarked invariably to cover them with leaves, never failing also to do the same previously to her short absences in quest of food. In the warm climate of the West Indies this singularity is not easily accounted for. The food of these birds varies with the season, and consists of grain, worms, and insects, as well as fruit. They appear in flocks of about twenty, are rank and unpalatable as food, and by a chattering and screaming noise, which they utter under every impression of danger, often interrupt and defeat the hopes of the sportsman, by alarming valuable game beyond the reach of his efforts.

CROW. See CORVUS.

CROW, in mechanics, a kind of iron-lever with a claw at one end, and a sharp point at the other: used for heaving or purchasing great weights.

CROW'S *feet*, in the military art, machines of iron, having four points, each about three or four inches long, so made, that whatever way they fall there is still a point up: they are thrown upon breaches, or in passes where the enemy's cavalry are to march, proving very troublesome by running into the horse's feet and laming them.

CROWEA, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted; petals five, sessile; stamina flat, subulate, connected by interwoven hairs; antheræ growing longitudinally from the inner part of the filaments; capsules five-united; seeds coated. One species; *viz.* the saligna, a native of Australasia.

CROWN, an ornament worn on the head by kings, sovereign princes, and noblemen, as a mark of their dignity.

CROWN, in heraldry, is used for the representation of that ornament, in the mantling of an armory to express the dignity of persons. See HERALDRY.

CROWN, in commerce, a general name for coins, both foreign and domestic, which are of the value of five shillings sterling. See COIN.

SERPENTES.

Fig. 1. **Acrochordus** *dubius, doubtful Acrochordus. Fig. 2.* **Boa** *canina, canine Boa.*
Fig. 3. **Crotalus** *horridus, banded rattle snake.*

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Crown, in architecture, denotes the uppermost member of the cornice, called also corona.

Crown, in astronomy, a name given to two constellations, the one called borealis, the other meridionalis. See Corona.

Crown, in geometry, is a plain ring included between two concentric perimeters, and is generated by the motion of some part of a right line round a centre, the said moving part not being contiguous to the centre.

The area of a crown will be had by multiplying its breadth by the length of the middle periphery; for a series of terms in arithmetic progression being $n \times \frac{a+w}{2}$, that is, the sum of the first and last multiplied by half the number of terms, the middle element must be $\frac{a+w}{2}$; wherefore that multiplied by the breadth, or sum of all the two terms, will give the crown.

Crown *of colours*, certain coloured rings which, like halos, appear about the body of the sun or moon, but of the colours of the rainbow, and at a less distance than the common halos. These crowns Sir Isaac Newton shews to be made by the sun's shining in a fair day, or the moon in a clear night, through a thin cloud of globules of water or hail, all of the same bigness. And according as the globules are bigger or lesser, the diameter of these crowns will be larger or smaller; and the more equal these globules are to one another, the more crowns of colours will appear, and the colours will be the more lively.

Crown *office*. The court of king's bench is divided into the plea side and the crown side. In the plea side it takes cognizance of civil causes, in the crown side it takes cognizance of criminal causes, and is thereupon called the crown office. In the crown office are exhibited informations in the name of the king, of which there are two kinds: 1. Those which are truly and properly the king's own suits, and filed *ex-officio* by his own immediate officer, the attorney-general. 2. Those in which, though the king is the nominal prosecutor, yet it is at the relation of some private person or common informer: and these are filed by the king's coroner and attorney, usually called the master of the crown office.

Crown *wheel of a watch*, the upper wheel next the balance, which by its motion drives the balance, and in royal pendulums is called the swing-wheel.

Crown *work*, in fortification, an outwork having a very large gorge, generally the length of the curtin of the place, and two long sides terminating towards the field in two demi-bastions, each of which is joined by a particular curtin to a whole bastion, which is the head of the work. The crown-work is intended to inclose a rising ground, or to cover the head of a retrenchment.

CRUCIANELLA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx two-leaved; corolla one-petalled, funnel-form, with a filiform tube and tailed border; seeds two, linear. There are nine species. These are herbaceous plants; leaves stellate, from four to six in a whorl, often linear; flowers bracted, in close terminating spikes, sometimes in corymbs. Natives of warm climates.

CRUCIBLE, a chemical vessel made of earth, and so tempered and baked as to endure the greatest fire. See Laboratory.

CRUCIFORM, in botany, a term applied to cross-shaped flowers, or flowers consisting of four petals, which spread at the top in form of a cross. Of this kind is the stock-gillyflower, &c.

CRUDIA, in botany, a genus of the Decandria Monogynia class and order. Calyx one-leafed, with a two-cleft border; no corolla; filaments dilated at the base; capsule orbicular; about two-seeded. Two species, *viz.* the spicata and aromatica, found in Guiana.

CRUIZERS, in naval affairs, vessels, as the name imparts, employed on a cruize. They are, in truth, small men of war made use of in the channel and elsewhere, to secure our merchant's ships and vessels from the enemy's small frigates and privateers. They are generally formed for sailing well, and are commonly well manned. The safety of the trade in the channel requires keeping out such ships at sea.

CRUSTACEOUS *fish*, in natural history, those covered with shells, consisting of several pieces or scales, as those of crabs, lobsters, &c. These are generally softer than the shells of the testaceous kind, which consist of a single piece, and commonly thicker and stronger than the former; such as those of the oyster, scallop, cockle. See Cancer.

CRUSTS, in chemistry. By crusts we understand those bony coverings of which the whole external surface of crabs, lobsters, and other similar sea animals are composed.

Mr. Hatchett found them composed of three ingredients: 1. A cartilaginous substance possessing the properties of coagulated albumen. 2. Carbonate of lime. 3. Phosphate of lime. By the presence of this last substance they are essentially distinguished from shells, and by the great excess of carbonate of lime above the phosphate they are equally distinguished from bones. Thus the crusts lie intermediate between bones and shells, partaking of the properties and constitution of each. The shells of the eggs of fowls must be referred likewise to the class of crusts, since they contain both phosphate and carbonate of lime. The animal cement in them, however, is much smaller in quantity. From experiments it is extremely probable that the shells of snails are composed likewise of the same ingredients, phosphate of lime having been detected in them by these chemists.

Mr. Hatchett examined the crusts of crabs, lobsters, prawns, and crayfish. When immersed in diluted nitric acids these crusts effervesced a little, and gradually assumed the form of a yellowish-white soft elastic cartilage, retaining the form of the crust. The solution yielded a precipitate to acetate of lead, and ammonia threw down phosphate of lime. Carbonate of ammonia threw down a much more copious precipitate of carbonate of lime.

On examining the crust which covers different species of echini, Mr. Hatchett found it to correspond with the other crusts in its composition. Some species of starfish yieldeth phosphate of lime, others none: hence the covering of that genus of animals seems to be intermediate between shell and crust.

CRUZITA, in botany, a genus of the Tetrandria Digynia class and order. Atriplices, Jussieu. Essential character: inner calyx four-leaved; outer three-leaved; corolla none; seeds one. One species, *viz.* C. hispanica, a native of South America.

CRYPSIS, in botany, a genus of the Diandria Digynia class and order. Natural order of Grasses. Essential character: calyx glume two valved, one-flowered; corolla glume two-valved, awnless. One species, *viz.* C. aculeata, prickly crypsis. This grass is a native of the South of Europe and Siberia; it is common also in Barbary.

CRYPTOCEPHALUS, in natural history, a genus of insects of the Coleoptera order. Characterised by filiform antennæ; four feelers; thorax margined; shells immarginate; body somewhat cylindrical. This is a very extensive genus, nearly 300 species have been enumerated. They are divided into two sections, A. feelers equal, filiform; B. feelers unequal; fore-ones hatchet-shaped. A. is subdivided into *a*, jaw one-toothed; 1. lip entire, cylindrical; 2 lip entire, palpigerous at the tip; 3. lip bifid; body oblong: *b*, jaw bifid; body oblong. In B. there are some of the genera that have horny lips; others with lip membranaceous, entire; and some whose lip is membranaceous, widely emarginate.

CRYPTOGAMIA, in botany, the name of the twenty-fourth class of Linnæus's Sexual Method, consisting of plants, in which the parts of fructification are, either from their minuteness or their situation, entirely concealed or imperfectly visible.

CRYPTOSTOMUM, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx ventricose, five-cleft; tube of the corolla inserted into the throat of the calyx; border five-cleft; nectary five-toothed, closing the mouth of the corolla; berry; seeds scarred. There is but one species, *viz.* C. Guianense, Guiana cryptostomum.

CRYSTALLINE *humour*, in anatomy, a thick, compact humour, in form of a flattish convex lens, situated in the middle of the eye, serving to make that refraction of the rays of light, necessary to make them meet in the retina, and form an image thereon, whereby vision may be performed. See Eye.

CRYSTALLIZATION. When the attraction of aggregation has been weakened, either by the application of heat, or of a chemical affinity, and is suffered to resume its force more slowly or equally, the particles are not united indiscriminately, but in uniting assume a particular arrangement; and thus form masses of regular figures, bounded by plain surfaces and determinate angles. When aggregation is exerted in this manner, and with this result, the operation is named crystallization, and the regularly figured masses are denominated crystals.

Crystallization is of two kinds: first, as it takes place from the reduction of temperature in a body which has had fluidity communicated to it by the operation of heat; and, secondly, as it proceeds from the diminution of the solvent power of a fluid, which has communicated fluidity to a solid by having combined with it.

Of the first kind of crystallization, water affords an example in passing into ice by a

reduction of its temperature. At first long and slender spiculæ form in the fluid, and from these others shoot out at a certain angle, and this continues till the interstices are filled with the crystals, and the whole becomes a solid transparent mass. We have also examples of it in the metals, which when melted and cooled slowly, assume symmetrical forms. Some inflammables, as sulphur, crystallize in a similar way.

Of the second kind of crystallization, the principal examples are derived from the order of salts, and a few other solids, soluble in water; and with regard to this, several facts of importance require to be stated.

The solution of a solid in a fluid, is in almost every case increased by heat, which weakens cohesion: hence a larger quantity of the solid is kept in solution at a high, than a low temperature. If, therefore, we prepare a solution of salt in hot water, the solution being saturated, or the fluid having dissolved as much of the salt as it can do, on allowing it to cool, the portion of the salt which the heat enabled the fluid to dissolve, will separate; and unless the cooling of the solution has been very rapid, the particles of the solid, in approaching to each other, will pass into those regular arrangements which constitute crystals.

The same result will be obtained by withdrawing parts of the fluid in which the solid is dissolved. If this be done slowly, or by spontaneous evaporation, the particles will obey the law of attraction which unites them in regular forms; the crystals are in this way formed frequently more regular, and of a larger size than by the former method of reducing the temperature of the solution: some can be crystallized only in this method.

In both cases the fluid in which the crystals form, is still a saturated solution of the solid, and by a farther evaporation, joined sometimes with subsequent cooling, will again crystallize.

In general it holds true, that the slower the formation of a crystal, the more perfect is its symmetrical arrangement; it is also larger, harder, and more transparent: whereas, when the process is too rapid, or is disturbed by agitation, or other causes, the arrangement is less regular and the form incomplete. Hence the crystals formed by nature are so much more perfect than those produced by artificial processes.

Crystallization is promoted by affording a nucleus, or solid point, at which it may commence, and still more so if a crystal be introduced into the solution; crystallization immediately commences from it, if the solution be a saturated one, and it is even capable of causing part of the solid to be separated, if the temperature at which it takes place could have retained in solution. Even the regularity of the figure of this crystal, seems to have an effect in rendering the crystallization more or less regular; and on this Le Blanc has founded a method of obtaining large and perfect crystals. It consists in selecting very regular crystals of a salt that have been newly formed, and putting them into a saturated solution of the same salt. They increase in size; and as the side which is in contact with the vessel receives no increase, they are to be turned daily to preserve their regularity. After some time, the largest and most regular of these crystals are to be selected, and the same process repeated on them; and thus crystals much larger and more regular than are usually formed in a solution may be obtained.

The access of the air has an important influence on this process. If a saturated solution of salt when hot, be put into a vessel from which the air is excluded, it does not crystallize even when cold. But if the air be admitted, the crystallization immediately commences and proceeds with rapidity. It has been shewn by Dr. Higgins, that any pressure, equivalent to that of the atmosphere, as the pressure of a column of mercury, has the same effect.

During crystallization a quantity of heat is rendered sensible. In many cases the volume of the substance crystallizing is enlarged, as in the example of water, of iron, and of the greater number of salts; but in others the volume is diminished. Quicksilver, in congealing, contracts about $\frac{1}{23}$ of its whole bulk, yet it exhibits the crystalline texture; and when the congelation is partial, the crystalline figure can even be discovered.

Crystals deposited from water always contain a part of it which is retained by the affinity of the solid, and has passed with it into the concrete form. It is termed water of crystallization. Its quantity is very various; sometimes it equals or exceeds the weight of the solid, and sometimes it amounts only to a few parts in the hundred. Much of the cold produced during the solution of salts in water, is owing to this water of crystallization passing into the fluid state: hence crystallized salts gene-

rally produce more cold than when they are uncrystallized. If the water of crystallization be expelled from a crystal, it looses its transparency, and at length its form. Crystals which part with their water of crystallization when exposed to the atmosphere, are said to effloresce, and to deliquesce when they attract water and become humid.

Some substances have so strong an affinity for the fluids in which they are dissolved, or so little tendency for cohesion, that they do not crystallize. In some cases their crystallization may be effected by adding to the solution a substance exerting an affinity to the fluid, and of course weakening its affinity for the solid it dissolved.

As different bodies require very different quantities of water for their solution, it is possible when two such bodies are dissolved in one fluid, to obtain them separate by crystallization, the one which is least soluble, or most disposed to crystallize, first passing into the solid form; and by farther evaporation the other is obtained. A fact on this subject, somewhat singular, is noticed by Mr. Kirwan. If into a saturated solution of two salts in water, a crystal of either be put, that salt crystallizes in preference to the other.

By crystallization, also, salts, the solubility of which is unequally promoted by heat, may be obtained separately from the same solution. Thus, if one salt be much more soluble in hot than in cold water, and another be equally soluble, or nearly so at any temperature, on evaporating the solution sufficiently, the latter salt will crystallize while the solution is hot; on cooling, the other will shoot into crystals; and by alternate evaporation and cooling, the two may be obtained uncombined, though generally with a little intermixture of each other.

Sometimes, however, when two salts are in solution in the same fluid, and have even different tendencies to crystallization, their mutual affinity leads them to crystallize in one mass, and even to assume a form different from that in which separately they would have crystallized.

In other cases this mutual affinity, between substances in solution, is sufficient to resist their crystallization, or to render it more difficult.

Crystallization sometimes takes place, when bodies in the gaseous form become subject to the attraction of aggregation, as in sublimates; and even solids separated from a liquid by chemical action, in some instances at the moment of their separation, assume a crystallized form.

Every substance in crystallizing is disposed to assume a particular figure. Thus, sea-salt crystallizes in the form of a cube; nitre in that of a hexaedral prism; sugar in that of a four or six-sided prism, with triedral terminations. The crystalline figure in any substance, however, is not invariable, but may be altered by circumstances affecting the crystallization; and we find the same substance crystallized under a variety of forms. Sea-salt crystallizes, not only in cubes, but also in octaedrons; and carbonate of lime is found in nature in the form of an hexaedral prism, an hexaedral, and a triedral pyramid.

The effect of light upon the act of crystallization is very remarkable. It is found in general, that the crystals of salts are larger and better formed in the dark than when light falls upon the solution. But this relates only to such crystals as are formed in the fluid. In many, and indeed most salts, there are crystals formed, during the spontaneous evaporation of the solution, which rise above the surface into the air, either in contact with the sides of the vessel, or supported by their own structure. This phenomenon is very striking and curious, and it appears to have been well determined by experiments of Chaptal and others, that it does not take place without the presence of light. See VEGETATION OF SALTS.

CRYSTALLOGRAPHY. Hauy has succeeded in developing the theory of crystals, so far as to shew, that in every crystallized substance, whatever may be the difference of figure which may arise from modifying circumstances, there is in all its crystals a primitive form, the nucleus, as it were, of the crystal; invariable in each substance, and by various modifications, which he points out, giving rise to the numerous secondary, or actually existing forms.

The fact which led to these views, is that crystals can be mechanically divided only in certain directions, so as to afford smooth surfaces, a fact long known by those who work on the gems. Suppose we have a crystal of calcareous spar, a regular hexaedral prism, represented in plate crystallography, fig. 5 and 6, if we endeavour to divide it parallel to the edges which form the outlines of the basis of the prism, we shall find that three of these edges taken alternately, are the upper extre

mity of the edges $l f, d c, b m$, readily yield to this division by a knife struck in the proper direction; but that the other three, those which are intermediate, $f d, c b$, and $m l$, cannot be divided in a similar manner; and if broken by a greater force, the fracture, instead of being polished like the others, is rugged and uneven. If we repeat the experiments at the under extremity of the prism, we shall find here also that segments of three only of the edges can be detached; but these edges, instead of being the corresponding one with those devisable at the upper extremity, that is, $l f, c d, b m$, are the intermediate ones $f d, c d, b m$, are the intermediate ones $d f, c b$, and $m l$.

The six divisions compose so many trapeziums. Three of these are represented in fig. 6, namely, the two which cut off the edges $l f, c d$ represented by the dotted lines $p p$, $o o$ and $a a$, $k k$, and that which cuts off the inferior edge $d f$, and which is marked by the dotted lines $n n$, $i i$.

Each of these trapeziums will have a smoothness and lustre, from which it can be perceived, that it coincides with one of the natural joinings, the assemblage of which form the prism. The prism cannot be divided in any other directions than these. But if the division be continued parallel to the first segments, it necessarily happens, that on one hand the surfaces of the bases of the prism become narrower, and that on the other hand the heights of the sides diminish; and at the point at which continuing the section, the bases disappear, the prism will be changed into a dodecaedron, with pentagonal faces (fig. 7); six of which, $o o i$ O e, o I $k i i$, &c. are the remains of the sides of the prism, and the other six, E A I $o o$, O A K $i i$, &c. are the immediate results of the mechanical division.

In this, and the two succeeding figures, the hexaedral prism, which circumscribes the solid extracted from it in the division, is still represented to shew better the progress of the operation.

Beyond this point, the planes at the extremity preserve their figure and dimensions, while the lateral planes continue to diminish in height, until the points o, k of the pentagon o I $k i i$ coinciding with the points i, i, and also the other points similarly situated having a like coincidence, each pentagon is reduced to a simple triangle, as is represented in fig. 8.

Lastly, by continuing the section the triangles are made to disappear, so that there remains no vestige of the surface of the original prism; but in place of it we have the obtuse rhomboid E A I O (fig. 9), which is therefore the nucleus, or primitive form.

This discovery of the method of dividing a crystal was made by Hauy, in examining a crystal of calcareous spar which had been detached from a group of which it formed a part. He observed that the fracture had happened at one of the edges of the base of the prism, and that its surface was perfectly smooth and regular. Attempting to detach a segment in a similar direction from the contiguous edge, he could not succeed, but the one next to it was easily divided; and proceeding in this manner, he was able to effect the mechanical division of the crystal in the manner already explained. Struck with the important result of the experiment, he applied the same method to other crystalline forms of the same substance, and obtained from them the same result; the crystal, whatever was its figure, being by this mechanical division converted into a rhomb. Thus in the dodecaedron, composed of two six-sided pyramids joined by the base, the primitive form may be obtained at once by making a first section, on the edges E O, O I, fig. 10; a second, on the edges I K, G K; a third, on G H, E H; a fourth, on O I, I K; a fifth, on G K, G H; and lastly, a sixth, on E H, E O; and the result is, that these edges become the same with the lateral edges of the primitive form, as may be perceived from mere inspection of fig. 11, which represents this primitive form described in the dodecaedron. He then applied it to other crystalline substances, and found, that from these also, by discovering the joints by which the laminæ composing the crystals were united, a certain primitive form might be extracted. That of fluor spar, is an octaedron; and that of the heavy spar, a prism with rhomboidal bases; of corundum, a rhomboid somewhat acute; of beryl, a hexaedral prism; and of the elba iron-oar, a cube. Each of these forms is constant with regard to the species, and is that from which all the forms of the varieties, often extremely numerous, are derived. The latter are denominated by Hauy, secondary forms. Sometimes, though rarely, the primitive and secondary forms are the same.

It is not every crystallized substance, however, that admits of this mechanical analysis. But with regard to those that have hitherto refused it, Hauy has re-

marked, that their surface striated in a certain direction, or the relation subsisting among the different secondary forms of the same substance, afford indications which lead to the determination, with at least much probability, of their primitive forms.

Such is the process, by which Hauy establishes what he names the "Primitive Form of Crystals," and which he defines, "A solid of a constant form, inserted symmetrically in all the crystals of the same species, and the faces of which observe the directions of the layers which compose these crystals." The primitive forms hitherto observed, are reduceable to six: the parallelopipedon, which includes the cube, the rhomb, and all the solids which are terminated by six faces parallel two and two; the tetraedron; the octaedron; the regular hexaedral prism; the dodecaedron, with equal and similar rhomboidal planes; and the dodecaedron with triangular planes.

Hauy carries the division of crystals still further, however, than the primitive forms. The solid which constitutes it, is not the last term of the mechanical analysis; it may always be still farther subdivided parallel to its different faces, and sometimes even in other directions. All the enveloping matter is equally divisible by sections parallel to the faces of the primitive forms; and the only limit to this possible division is that placed by the composition of the substance. The calcareous spar, to take it as an example, may be reduced to a particle beyond which the division cannot be carried, without resolving it into its elements, lime and carbonic acid; or at least it may be reduced to a particle, beyond which, if its minuteness allowed us to operate upon it, it is demonstrable its figure would not change. To these last particles, the result of the mechanical analysis, Hauy gives the name of integrant particles, and their union constitutes the crystal. Their forms, so far as experiment has been carried, are three: the tetraedon, the simplest of the pyramids; the triangular prism, the simplest of prisms; and the parallelopipedon, the simplest of solids, which have their faces parallel, two and two. There is little doubt that it is between these that the attraction of cohesion is immediately exerted.

The primitive forms, and the figures of the integrant particles, being determined, it remains to complete the theory of the structure of crystals, to shew by what arrangements the secondary forms, in other words, the actually existing crystals, are produced.

The nucleus of the crystal is the symmetrical solid which constitutes its primitive form, arising from the union of the integrant particles, either by their faces or their edges; and the additional matter, which forms the crystal, consists of layers of these particles superadded to that nucleus, and arranged on its faces; and to account for the formation of the crystal under a figure different from that of its primitive form, these layers, as they recede from it, are supposed to decrease, in the space they occupy, from the regular abstraction of one or more ranges of the integrant particles. This decrease may take place in various modes; and according to these, different figures of crystallization will be produced.

Thus, to take the simplest example, let us suppose the primitive form is a cube; it is easy to conceive, that on each of its six sides may be reared a series of decreasing layers, or laminæ, composed entirely of cubical particles, each layer diminishing on each of its edges by one row of the minute cubes of which it consists. The laminæ thus decreasing as they recede from the base on which they rest, until the apex consists of a single particle, it is obvious, that on each side of the cube a four-sided pyramid will be formed. Two of these are represented, (fig. 12.) A B C D, G B C G.

We shall thus have, then, six four-sided pyramids, and of course 24 triangles, such as A B C, B C E, C E G, &c. But since the decrease is uniform on all the sides, as from the line B C to A, and from the same line to E, it must also be uniform from A to E; it is obvious, therefore, that the side A B C of the one pyramid will be found exactly in the same plane as the side B C E of the adjacent pyramid; so that the entire surface of these will be the rhomb A B E C. The case must be the same with all the others. The 24 triangles will therefore be reduced to twelve rhombs, and the figure will be a dodecaedron, very remote from the primitive form. Now a crystal of this figure, and having this primitive form, would be resolved into that form, merely by cutting off the six solid angles, by sections, in the direction of the small diagonals of the sides, which go to the formation of these angles. We should thus successively uncover six squares, which will be the faces of the primitive cube.

In explaining the structure of a crystal, although the representation in the figure be

such as to shew the decrease of the laminæ by rows of particles of such a size as to give a surface uneven, similar to a succession of steps, it is obvious, that if we substitute for this the delicate structure of nature, the number of laminæ may be so great, and the number of their cubical particles such, that the depression or channel at their edges will be altogether imperceptible to our senses, and the surfaces will appear perfect planes.

Such is an example of the production of a secondary from a primitive form by a superposition of laminæ, decreasing according to a certain law. It is obvious that the laws of decrement may be various, and accordingly the decrements stated by Hauy are of four different kinds: first, decrements on the edges, or parallel to the sides, of the primitive form, of which the above is an example. 2. Decrements on the angles, that is, decrements of which the lines are parallel to the diagonals of the faces of the primitive form. 3. Intermediate decrements, or those which are parallel to lines situated between the diagonals and edges of that form. 4. Mixed decrements, in which the number of ranges abstracted in breadth or in height give proportions, the two terms of which are beyond unity.

These four laws of decrement explain, by the modifications of which they are susceptible, of all the varieties of form under which crystals are presented to us. These modifications are reduced to the following: 1. Sometimes the decrements take place on all the edges, or on all the angles. 2. Sometimes on certain edges or certain angles only. 3. Sometimes they are uniform by one, two, three ranges, or more. 4. Sometimes the law varies from one edge to another, or from one angle to another. 5. In some cases the decrements on the edges correspond with the decrements on the angles. 6. Sometimes the same edge or the same angle undergoes successively several laws of decrements. And, lastly, there are cases in which the secondary crystal has faces parallel to those of the primitive form, and which give rise to new modifications from their combinations with the faces resulting from the decrements.

With such diversity of laws the number of forms which may exist is immense, and far exceeds what have been observed. Confining the calculation to two of the simplest laws, those which produce subtractions by one or two ranges, it is shewn that carbonate of lime is susceptible of 2044 different forms, a number 50 times greater than that of the forms already known; and if decrements of three and four ranges be admitted into the combination, the calculation will give 8,388,604 possible forms of the same substance. And even this number may be much augmented in consequence either of intermediate or mixed decrements being taken into account.

In concluding this sketch of Crystallography, which we have extracted from the excellent "System of Chemistry" by Murray, we have also thought it proper, with him, to give the figures of the more usual forms of crystals, and their modifications, with the terms and definitions of Werner, instead of following Hauy in his minute, though valuable details.

It is necessary to premise, that the parts of which a crystal is conceived to be composed, are planes, edges, and angles. Planes, according to the usual geometrical definition, are surfaces lying evenly between their bounding lines: they are distinguished into lateral, which are considered as those parts of the surface of the body which are of the greatest extent, and which form its confines towards its smallest extent; and extreme or terminal, which are those of smallest extent, and form the bounds of the body towards its largest extent. Edges are formed by the junction of two planes under determinate angles; they also are lateral, or those formed by the junction of two lateral planes; and terminal formed by the junction of two terminal planes, or of a terminal with a lateral plane. Lastly, angles are formed by the junction of three or more planes in one point.

Werner admits even primary figures of crystals which are susceptible of numerous modifications. These figures are the icosaedron, the dodecaedron, the hexaedron, which includes the cube and the rhomb, the prism, the pyramid, the table, and the lens.

1st. The icosaedron, fig. 13, is a solid, consisting of twenty equilateral triangular planes, united under equal angles. 2d. The dodecaedron, fig. 14, or solid of twelve equal or pentagonal faces. 3d. The cube, fig. 15, or solid, composed of six quidrilateral planes united at right angles. 4th. The rhomb, fig. 16, or solid, of six quadrilateral planes united at oblique angles. 5th. The prism, or solid, of two terminal planes, parallel, equal, and similar, connected by quadrangular lateral planes having one direction; the number of late-

ral planes may of course be various; the usual form observed in crystals are the four-sided rectangular prism, fig. 17; and the six-sided equiangular prism, fig. 19. 6th, The pyramid, or solid, the base of which is a plane of an indeterminate number of sides, and the sides triangles, the vertices of which meet in one point, forming the summit: the more common varieties of this figure, as forms of crystals, are the three-sided pyramid, or tetraedron, fig. 20, and the four-sided pyramid, fig. 21. 7th. The table, which, strictly speaking, is nothing but a very compressed prism; it is defined as composed of two parallel lateral planes, and of an indeterminate number of terminal planes, connected with the lateral planes and with each other, and small, compared with the lateral ones; the principal varieties are, the oblique-angular, or rhomboidal four-sided table, fig. 23, the rectangular four-sided table, fig. 24, and the six-sided table, fig. 24. Lastly, The lens, fig. 25, a solid, consisting only of two planes, which are curved; of which there are two varieties, one composed of two convex planes, and another composed of a convex and a concave plane. These simple figures are modified by combination, by truncation, by bevelment, and by acumination.

The modification by combination are confined to the pyramids, and these are frequent, two pyramids being joined by the base; the lateral planes of the one being set either directly on the lateral planes of the other, as in the double four-sided pyramid, or octaedron, fig. 26, or obliquely, as in the double four-sided pyramid, fig. 27. Fig. 28. is the double six-sided pyramid.

A crystal is said to be truncated, when any or all of its solid angles or edges appear cut off, so that where there would have been an edge or angle we have a plane, as has already been represented in fig. 2, and 3. These two figures represent forms arising from the truncation of the cube: fig. 29, shews the cube with the angles and edges truncated: fig. 30, the six-sided prism, with truncated terminal edges: fig. 31, the same prism, with both the lateral and terminal edges truncated.

A crystal is said to be bevelled, when its edges, angles, or terminal planes are so altered, that instead of an angle edge or terminal plane, there appear two smaller converging planes, which terminate in an edge: fig. 32, shews the cube with bevelled edges: fig. 33, the three-sided pyramid, with bevelled edges: fig. 34, the oblique four-sided prism, bevelled on both extremities.

Lastly, the forms of crystals are altered by acumination. This is that kind of alteration in which, in place of the angles or terminal planes of a crystal, there are three or more planes converging and forming a point or edge: fig. 35, shews the cube, with angles acuminated by three planes set on the lateral planes: fig. 36, the rectangular four-sided prism, acuminated by four planes set on the lateral planes: fig. 37, the six-sided prism, acuminated by six planes set on the lateral planes. This kind of modification is often described as consisting of the primary form, with pyramidal terminations.

The forms of crystals from the preceding modifications are frequently still more altered, and rendered complicated, by being super-added and combined; and by the extent of the modifications, one form frequently passes into another. The figures of crystals are likewise rendered complicated by aggregation, two or more crystals of the same substance being more or less closely united.

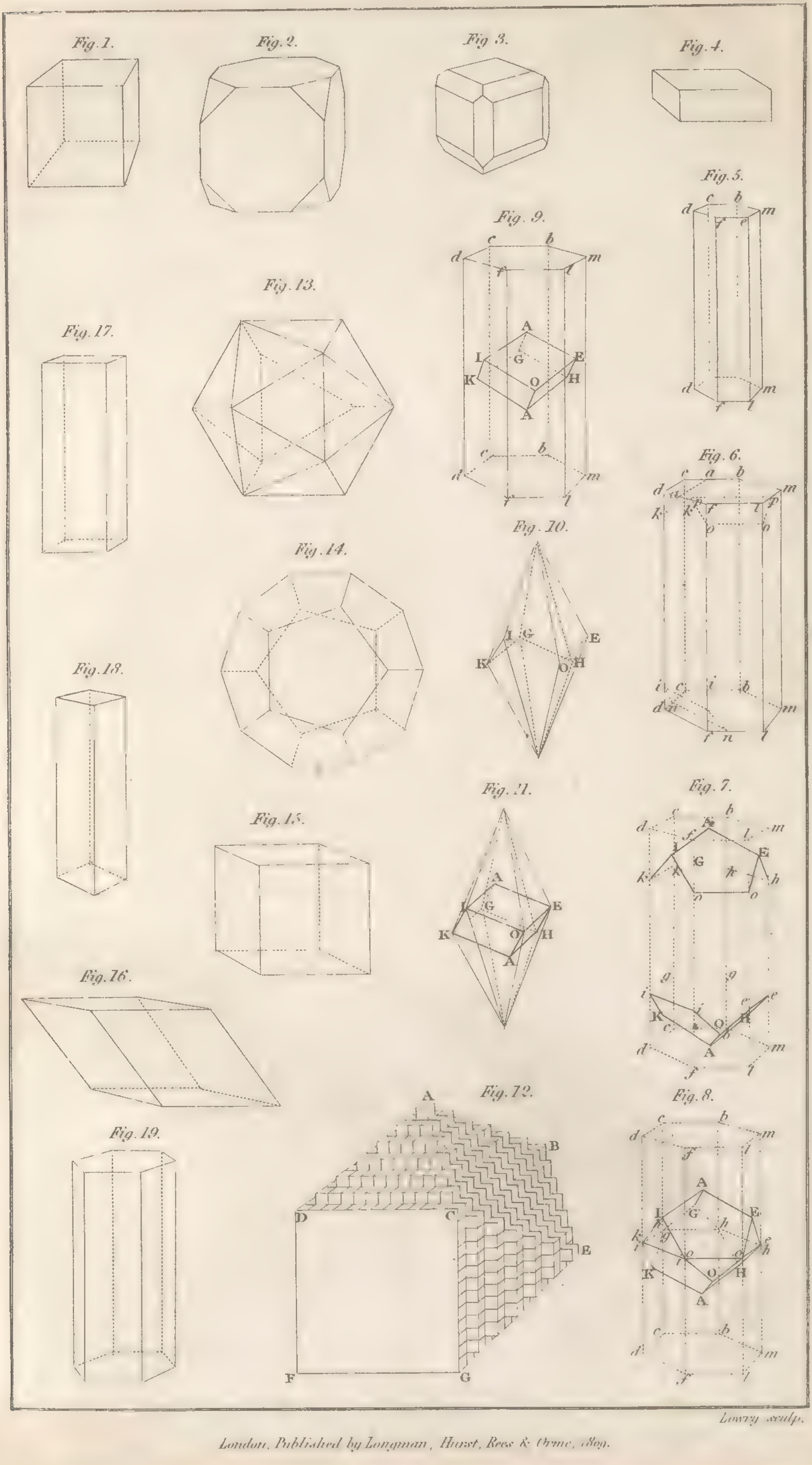
For the more minute details of this subject, particularly as related to mineralogy, reference may be had to Weaver's translation of the "External Characters of Minerals," by Werner; or the treatise on the same subject by Professor Jameson. See Crystallization.

CRYTANDRA, in botany, a genus of the Pentandria Monogynia class and order. Calyx five-leaved; corolla tubular, with a five-clefted border, and five-hooded scales between the segments; stamina inserted in the throat under each scale; stigma three-cleft; capsule superior, three-valved, three-celled from the inflected valves; seeds solitary, compressed. One species, a shrub found in Australasia.

CUBÆA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx turbinate, five-parted, unequal, permanent; petals five, unequal; filaments villose, three shorter; germ pedicelled; legume villose, six or seven-seeded. There are two species.

CUBATURE *of a solid*, in geometry, the measuring the space contained in it; or finding the solid content of it.

CUBE, in geometry, a solid body, consisting of six equal square sides. The solidity



Lowry sculp.

London, Published by Longman, Hurst, Rees & Orme, 1809.

Fig. 20.

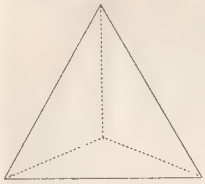


Fig. 21.

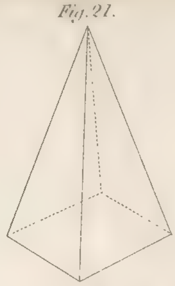


Fig. 22.

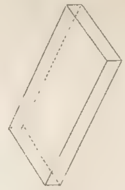


Fig. 23.

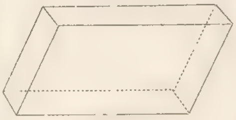


Fig. 24.

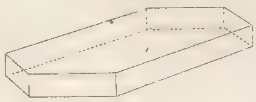


Fig. 25.

Fig. 26.

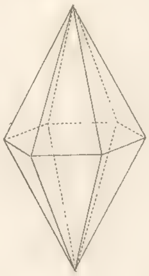


Fig. 27.

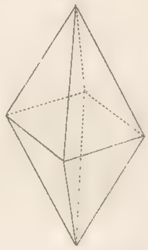


Fig. 28.

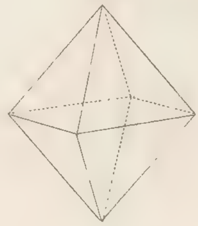


Fig. 29.

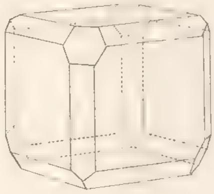


Fig. 30.

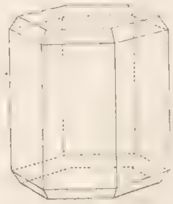


Fig. 31.

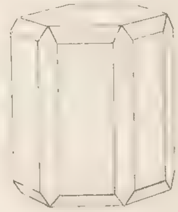


Fig. 32.

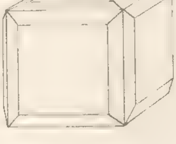


Fig. 33.

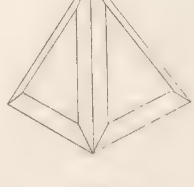


Fig. 34.

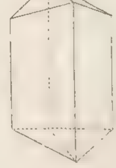


Fig. 35.

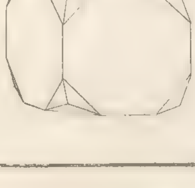


Fig. 36.

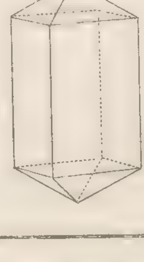
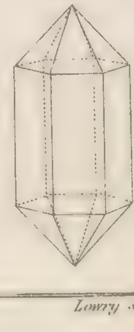


Fig. 37.



Lowry sculp

London. Published by Longman, Hurst, Rees & Orme, 1809.

of any cube is found by multiplying the superficial area of one of the sides by the height. Cubes are to one another in the triplicate ratio of their diagonals; and a cube is supposed to be generated by the motion of a square plane, along a line equal to one of its sides, and at right angles thereto; whence it follows, that the planes of all sections, parallel to the base, are squares equal thereto, and, consequently, to one another. See BODY.

CUBE, *duplication of*, is the finding the side of a cube that shall be double in solidity to a given cube, a problem of great celebrity, first proposed by the oracle of Apollo at Delphos, which, being consulted about the mode of stopping a plague then raging at Athens, returned for answer, that the plague should cease when Apollo's altar, which was cubical, should be doubled. Hence it is called the Delian problem. This problem cannot be effected geometrically, as it requires the solution of a cubic equation, or requires the finding of two mean proportionals, *viz.* between the side of the given cube, and the double of the same, the first of which two mean proportionals is the side of the double cube, as was first observed by Hippocrates. Let a be the side of the given cube, and x the side of the double cube sought, then $x^3 = 2\,a^3$ or $a^2 : x^2 :: x : 2\,a$, so that, if a and x be the first and second terms of a set of continued proportionals, then $a^2 : x^2$ is the ratio of the square of the first, to the square of the second, which, it is known, is the same as the ratio of the first term to the third, or of the second to the fourth, that is of $x : 2\,a$; therefore x being the second term, $2\,a$ will be the fourth: so that x, the side of the cube sought, is the second of four terms in continued proportion, the first and fourth being a and $2\,a$; that is, the side of the double cube is the first of two mean proportionals between a and $2\,a$.

CUBE, or *Cubic number*, in arithmetic, that which is produced by the multiplication of a square number by its root; thus, 64 is a cube number, and arises by multiplying 16, the square of 4, by the root 4.

CUBE, or *Cubic quantity*, in algebra, the third power in a series of geometrical proportionals continued; as a is the root, $a\,a$ the square, and $a\,a\,a$ the cube. All cubic numbers may be ranged into the form of cubes; as 8 or 27, whose sides are 2 and 3, and their bases 4 and 9; whence it appears, that every true cubic number, produced from a binomial root, consists of these parts, *viz.* the cubes of the greater and lesser parts of the root, and of three times the square of the greater part multiplied by the lesser, and of three times the square of the lesser multiplied by the greater, as,

$$\begin{array}{l} a\,a + 2\,a\,b + b\,b \\ a + b \\ \hline a\,a\,a + 2\,a\,a\,b + a\,b\,b \\ \qquad\qquad a\,a\,b + 2\,a\,b\,b + b\,b\,b \\ \hline a\,a\,a + 3\,a\,a\,b + 3\,a\,b\,b + b\,b\,b \end{array}$$

From hence it is easy to understand both the composition of any cubic number, and the reason of the method for extracting the cube root out of any member given.

CUBE *root of any number or quantity*, such a number, or quantity, which, if multiplied into itself, and then, again, the product thence arising by that number or quantity, being the cube root, this last product shall be equal to the number or quantity whereof it is the cube root, as 2 is the cube root of 8, because two times 2 is 4, and two times 4 is 8; and $a + b$ is the cube root of $a^3 + 3\,a^2\,b + 3\,a\,b^2 + b^3$.

Every cube number has three roots, one real root, and two imaginary ones, as the cube number 8 has one real root 2, and two imaginary roots, *viz.* $\sqrt{-3} - 1$ and $\sqrt{-3} + 1$; and generally if a be the real root of any cube number, one of the imaginary roots of that number will be $\frac{a + \sqrt{-3\,a\,a}}{2}$ and the other $\frac{a - \sqrt{-3\,a\,a}}{2}$

CUBEBS. See MATERIA MEDICA.

CUBIC, or *Cubical, Equation*, in algebra, one whose highest power consists of three dimensions, as $x^3 = a^3 - b^3$, or $x^3 + r\,x\,x = p^6$, &c. See EQUATION.

CUBIC *foot of any substance*, so much of it as is contained in a cube, whose side is one foot. See CUBE.

CUBIT, in the mensuration of the ancients, a long measure, equal to the length of a man's arm, from the elbow to the tip of the fingers. Dr. Arbuthnot makes the English cubit equal to 18 inches; the Roman cubit equal to 1 foot, 5,406 inches; and the cubit of the Scripture equal to 1 foot, 9,888 inches.

CUCKOW. See CUCULUS.

CUCKOW *spit*. See CICADA.

CUCUBALUS, in botany, a genus of the Decandria Trigynia class and order. Natural order of Caryophyllei. Essential charac-

ter: calyx inflated; petals five, having claws, but no crown; capsule three-celled. There are seventeen species.

CUCUJUS, in natural history, a genus of the Coleoptera order of insects: antennæ filiform; four feelers equal, the last joint truncate and thicker; lip short bifid, the divisions linear and distant; body depressed. There are about thirteen species.

CUCULLÆRIA, in botany, a genus of the Monandria Monogynia class and order. Calyx four-parted; corolla four-petalled, unequal spurred; filaments petal-like; anthers with distinct cells. One species found in the woods of Guiana.

CUCULLANUS, in natural history, a genus of the Vermes Intestina. Body sharp, pointed behind and obtuse before; mouth orbicular, with a striate hood. Most of this genus are viviparous, and generally intestinal. There are four sections: A, infesting the mammalia; B, infesting birds; C, infesting reptiles; and D, infesting fish. There are seven species besides varieties.

CUCULUS, the *Cuckow*, in natural history, a genus of birds, of the order Picæ. Generic character: bill smooth, somewhat bending and weak; nostrils surrounded by a small rim; tongue short and arrowed; toes two forward and two backward; tail wedge-formed of ten soft feathers. Gmelin enumerates fifty-five species, and Latham forty-six. The following are most deserving of notice: C. Canorus the Common Cuckoo. This bird is about fourteen inches long. It is found in Europe, Asia, and Africa. Its food consists of insects and the larva of moths, but when domesticated, which it may be without much difficulty, it will eat bread, fruits, eggs, and even flesh. When fattened it is said to be excellent for the table. It is in this country a bird of passage, appearing first about the middle of April, and cheering the vicinity of its habitation with that well-known note with which so many exquisite ideas and feelings are associated. This note is used only by the male bird, and is the intimation of love. It has, very rarely only, been heard, like the song of the nightingale, in the middle of the night. About the close of June this note ceases, but the cuckow remains in England till towards the end of September. It is imagined sometimes to continue in the country for the whole of the year, as it has occasionally been seen here so early as February. Cuckows are supposed to winter in Africa, as they are seen twice a year in the island of Malta.

With the history of these birds have been blended much fable and superstition; their manners, however, are unquestionably in a high degree curious, and fable in this, as in many other cases, is in a great degree connected with fact. It is almost universally agreed by naturalists that the cuckow does not hatch its own eggs, but deposits them in the nest of some other bird. Buffon mentions the names of twenty birds, or more, on whom the cuckow passes this fraud. Those most frequently duped by it, however, in this manner, are the yellow hammer, the water-wagtail, and the hedge-sparrow, and of these three, by far more than the other two, the hedge-sparrow. The most minute and attentive examiner into this extraordinary peculiarity, is Mr. Edw. Jenner, from whose observations on this interesting subject we shall select a few of the most important. He states, that the hedge-sparrow is generally four or five days in compleating her number of eggs, during which time the cuckow finds an opportunity of introducing to the nest one of its own, leaving the future management of it to the hedge-sparrow; and though it frequently occurs that the latter is much discomposed by this intrusion, and several of the eggs are injured by her and obliged to be removed from the nest, he states, that the egg of the cuckow is never of this number. When the usual time of incubation is completed, and the young sparrows and cuckow are disengaged from the eggs, the former are ejected from the nest, and the stranger obtains exclusive possession. A nest, built in a situation extremely convenient for minute observation, fell under the particular examination of this gentleman, and was found on the first day to contain a cuckow's and three hedge-sparrow's eggs. On the day following he observed a young cuckow and a young hedge-sparrow, and as he could distinctly perceive every thing passing, he was resolved to watch the events which might take place. He soon, with extreme surprise, saw the young cuckow, born only the day before, exerting itself with its rump and wings to take the young sparrow on its back, which it actually accomplished, and then climbed backwards with its burden to the verge of the nest, from which, with a sudden jerk, it clearly threw off its load; after which it dropped back into the nest, having first, however, felt about with the extremities of its wings as if to ascertain whether the clearance were completely effected. Several eggs were afterwards put

in to the young usurper, which were all similarly disposed of. He observes, that in another instance, two cuckows and a hedge-sparrow were hatched in the same nest, and one hedge-sparrow's egg remained unhatched. Within a few hours a conflict began between the two cuckows for the possession of the nest, which was conducted with extreme spirit and vigour, and in which each appeared occasionally to have the advantage, lifting its adversary to the very brink of the nest, and then, from exhaustion of strength, sinking with it again to the bottom. These vicissitudes of success were repeated and reiterated, but towards the close of the following day, the contest was decided in favour of the bird which was rather the larger of the two, who completely expelled his rival; after which, the egg and the young hedge-sparrow were dislodged with extreme facility. The infant conqueror was brought up by the step-mother with the most assiduous affection. The sagacity of the female cuckow appears not inconsiderable in her introducing her egg into the nests of birds whose young are inferior in size and strength to the young cuckow, and which the latter is consequently able to exclude without difficulty from its usurped dominions. See Aves, Plate VI. fig. 1.

C. Indicator, or the Honey-guide. This is an inhabitant of the interior of Africa, and is supposed to feed principally upon honey; it is at least extremely fond of it, and possesses an extraordinary sagacity in discovering where it is to be found. The Dutch farmers and Hottentots near the Cape, are reported to derive essential service from this bird. They imitate its peculiar sounds in the morning or evening, before it goes to feed, till they at length get within hearing and sight of it; and when it moves off to its repast, they follow, as correctly as they are able, the direction of its flight, and scarcely ever fail to arrive at some store of wild honey, of which, it is added, they make a liberal allowance to their little guide. It is certain, however, that these people have an extreme regard, and almost veneration for this bird, founded on its utility; and the curiosity of the celebrated Dr. Sparrman was not gratified by the destruction of one, as a specimen for his collections, without exciting high resentment and disdain.

CUCUMIS, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitaceæ. Essential character: calyx five-toothed; corolla five-parted. Male, filaments three. Female, pistil three-cleft; pome with argute seeds. There are thirteen species. These are all annual plants, with herbaceous scandent stems. C. sativus, common cucumber, generally cultivated for the tables, is so well-known, as not to require a particular description. C. melo, common or musk melon, belongs to this genus. There is a great variety of this fruit cultivated in this country, especially by those who supply the markets, where their size is chiefly regarded, so that by endeavouring to increase their bulk, the fruit becomes of little value. For a particular and elaborate description of this genus the reader may consult Martyn's excellent edition of Millar's Dictionary.

CUCURBITA, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitaceæ. Essential character: calyx five-toothed; corolla five-cleft. Male, filaments three. Female, pistils five-cleft; seeds of the pome with a swelling margin. There are seven species. The plants of this genus are very nearly allied to those of cucumis, and are distinguished from it chiefly by the swelling rim of the seed. Like them they are annual, with trailing herbaceous stems, furnished with tendrils for climbing.

CUCURBITACÆ, in botany, the name of the thirty-fourth order in Linnæus's fragments of a natural method, consisting of plants which resemble the gourd in external figure, habit, virtues, and sensible qualities. These are divided into two sections.—1. Those with hermaphrodite flowers, as the passion-flower. 2. Those with male and female flowers produced either on the same or distinct roots, as the cucumber, &c. In these the male flowers are generally separated from the female on the same root, and that either in the same angle of the leaves, as in the sicyos or serpent cucumber; or in different angles, as in the gourd, and some species of the bryony.

CUIRASS, a piece of defensive armour, made of iron plate, well hammered, serving to cover the body from the neck to the girdle, both before and behind.

CULEX, *gnat*, in natural history, a genus of insects of the order Diptera. Generic character: mouth consisting of setaceous piercers within a flexible sheath; antennæ approximate, filiform. Gmelin enumerates fourteen species. The common gnat is produced from an aquatic larva of a very singular appearance, which, when first

hatched from the egg, measure about the tenth part of an inch. The eggs of the gnat are deposited in close set groupes of three or four hundred together, and are very small: the whole groupe is placed on the surface of the water, close to the leaf or stalk of some water-plant. It feeds on the minute vegetable and animal particles which it finds in plenty on stagnant waters, in which it resides, the head being armed with hooks to seize on aquatic insects, and other kinds of food. When arrived at its full growth, it casts its skin, and commences chrysalis. In this state, like the larva from which it proceeded, it is loco-motive springing about in the water nearly in a similar manner. When ready to give birth to the included gnat, which usually happens in the space of three or four days, it rises to the surface, and the animal quickly emerges from its confinement. Gnats, as is known to every body, are very troublesome in all countries, but in Lapland during their short summer, the air is absolutely filled with such swarming myriads, that the poor inhabitants can scarcely venture out without first anointing their hands and faces with a composition of tar and cream, which prevents their attacks. This circumstance is not without its advantages; as the legions of larvæ which fill the lakes of Lapland, form a delicious and tempting repast to innumerable multitudes of aquatic birds, and thus contribute to the support of the very people which they so dreadfully torment. The musquito, of the West Indies and America is probably a variety of the common European gnat.

CULMINATION, in astronomy, the passage of any heavenly body over the meridian, or its greatest altitude for that day.

CULMUS, in botany, a straw, or haulm, the proper trunk of grasses which elevates the leaves, flower and fruit.

CUPHEA, in botany, a genus of the Dodecandria Monogynia class and order. Calyx six-toothed, unequal; petals six, unequal, inserted into the calyx; capsule one-celled, with a three-sided follicle. There is but one species.

CULPRIT, a formal reply of a proper officer in court, in behalf of the king, after a criminal has pleaded not guilty, affirming him to be guilty, without which the issue to be tried is not joined. After an indictment, for any criminal matter, is read in court, the prisoner at the bar is asked whether he is guilty, or not guilty, of the indictment? If he answers, not guilty, there is a replication by the clerk of the arraignments from the crown, by continuing the charge of the guilt upon him, which is expressed in the word culprit. The term culprit is a contraction of the latin *culpabilis*, and the old French word *prit* now *pret*, importing that he is ready to prove the criminal guilty.

CULVERIN, in the military art, a large cannon, or piece of artillery.

CUMINUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: involucres four-cleft; umbellules four; fruit ovate, striated. There is but one species, *viz.* C. cyminum cumin. Native of Egypt.

CUNILA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Verticillatæ, or Labiatæ. Essential character: corolla ringent; upper lip erect, flat; filaments two, barren; seeds four. There are four species.

CUNNINGHAMIA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character: calyx very small, four-toothed; corolla four-cleft, with a short tube; berry crowned with a two-celled two-seeded nut. One species, *viz.* C. sarmentosa.

CUNONIA, in botany, so called from Job Christopher, Cuno of Amsterdam; a genus of the Decandria Digynia class and order. Natural order of Saxifragæ, Jussieu. Essential character: corolla five-petalled; calyx five-leaved; capsule two-celled, acuminate, many-seeded; styles longer than the flower. There is but one species, *viz.* C. capensis, a native of the Cape of Good Hope.

CUP *galls*, in natural history, a name given to a curious kind of galls found on the leaves of the oak, and some other trees. They derive their name from their shape. Besides this species, the oak leaves furnish us with several others, of various shapes and sizes, which appear on the leaves at different seasons of the year. They all contain the worm of some small fly, that passes through all its changes in this habitation, being sometimes found in the worm, sometimes in the nymph, and sometimes in the fly state, in the cavity.

CUPANIA, in botany, so named from Francesco Cupani of Sicily, a genus of the Octandria Monogynia, or Polygamia Monoecia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx five-leaved; petals five-

cowled at the top; style trifid; capsule three-celled; seeds solitary, arilled. There are two species, *viz.* C. tomentosa, and C. glabra, both natives of the West Indies.

CUPEL, in chemistry, a small vessel, made generally of bone, it absorbs metallic bodies when changed by fire into a fluid scoria. See LABORATORY.

CUPELLATION. See ASSAYING.

CUPPING, in surgery, the operation of applying cupping glasses for the discharge of blood, and other humours, by the skin.

CUPRESSUS, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Coniferæ. Essential character: male calyx, scale of an ament; corolla none; anthers four, sessile, without filaments; female calyx of a strobile; scales one flowered; corolla none; styles, concave dots; nut angular. There are seven species. These are very beautiful and ornamental trees. C. horizontalis spreading cypress-tree is by far the largest growing tree, and is the most common timber in some parts of the Levant; it is said to resist the worm, moth, and all putrefaction, and to last many hundred years. The doors of St. Peter's Church at Rome were framed of this material, which lasted from Constantine to Pope Eugenius the Fourth's time, which was eleven hundred years, and were then sound and entire, when the Pope changed them for gates of brass. The coffins were made of this material, in which the Athenians used to bury their heroes, and the mummy chests brought with those bodies out of Egypt, are made of this wood.

CURATE, properly signifies the parson, or vicar of a parish, who has the charge or cure of the parishioners souls.

CURATE, also signifies a person substituted by the incumbent, to serve his cure in his stead. A cure is to be licensed or admitted by the bishop of the diocese or ordinary, having episcopal jurisdiction, and when a curate hath the approbation of the bishop, he usually appoints the salary too; and in such case, if he be not paid, the curate hath a proper remedy in the ecclesiastical court, by a sequestration of the profits of the benefice; but if he have no licence from the bishop, he is put to his remedy at common law, where he must prove the agreement.

CURATELLA, in botany, a genus of the Polyandria Digynia class and order. Natural order of Magnoliæ, Jussieu. Essential character: calyx five-leaved; petals four; styles two; capsule two-parted, with two seeds in a cell. There is but one species, *viz.* C. americana, a native of South America.

CURATOR, among civilians, a person regularly appointed to manage the affairs of minors, or persons mad, deaf, dumb, &c. In countries, where the civil law prevails, minors have tutors assigned them, till they are of the age of fourteen, between which and twenty-five, they have curators appointed them. There are also curators for the estate of debtors, and of persons dying without heirs.

CURATOR *of an university*, in the United Netherlands, an officer that has the direction of the affairs of the university, such as the superintendance of the professors, the management of the revenues, &c. these officers, being elective, are chosen by the states of each province. Leyden has three curators.

CURCULIGO, in botany, a genus of the Polygamia Monoecia class and order. Essential character: calyx none; corolla six-petalled; filaments six; pistil one; capsule; seeds beaked. There is only one species, *viz.* C. orchioides, native of shady, uncultivated places about Samulcotah, but by no means common. It is the Nallatady of the Telingas.

CURCULIO, *weevil*, in natural history, a genus of insects of the order Coleoptera: antennæ clavate, seated on the snout, which is horny and prominent; four-feelers, filiform. Of this genus there have been from 800 to 1000 species enumerated, and there are probably many more that have not been observed by authors who have treated on the subject. These have been separated into three sections, *viz.* A. jaw cylindrical, one-toothed. B. lip bifid; jaw bifid, short; snout short. C. lip rounded, horny; feelers very short. Of these the section A. is distinguished into *a*, snout longer than the thorax; thighs unarmed: *b*, snout longer than the thorax; thighs toothed: *c*, snout longer than the thorax; hind thighs formed for leaping: *d*, snout shorter than the thorax; thighs unarmed: *e*, snout shorter than the thorax; thighs toothed. The larvæ of this most splendid tribe of insects have six scaly legs, and a scaly head; some of them infest granaries, eating their way into grains of corn, and leaving nothing but the husk; some dwell in other seeds, or are lodged in the inside of artichokes, thistles, and various plants; and others devour the leaves of trees and herbs. C. salmarum, or palm weevil, is two

inches in length; its larva is large and white, and of an oval shape; it resides in the tenderest part of the smaller palm-trees, and is considered in the West Indies as one of the greatest dainties. C. nucum, or nut weevil, is the insect produced by the maggot residing in the hazel-nut. The insect makes its appearance early in August, and may be found creeping on hazel trees. The female singles out a nut, which she pierces with her proboscis, and then, turning round, deposits an egg in the cavity, and she thus proceeds till she has deposited in different nuts her whole stock of eggs. This is done while the nut is in its young state, which, however, is not injured by the process, but continues to grow, and gradually ripens. When the egg is hatched, the young larva begins to feast on the kernel. By the time that it has arrived at its full growth, and has nearly consumed the whole of the kernel, the nut falls, and the inclosed larva, not injured by the fall, continues in the nut some time longer, and then creeps out at the hole in the side, which it has previously made by gnawing in circular direction, and immediately begins to burrow or creep under the surface of the ground, where it lies dormant about eight months, and then casting its skin, commences a chrysalis of the same general shape and appearance with the rest of the beetle tribe; and it is not till the beginning of August that it arrives at its complete form, at which period it casts off the skin of the chrysalis, creeps to the surface, and commences an inhabitant of the upper world. During this state it breeds, and enjoys for a short time the pleasures of a more enlarged existence. To this genus belongs the weevil, properly so called. Many of the exotic species are large and of great beauty, but the most brilliant and most beautiful is C. imperialis, or diamond beetle, a native of Brazil, which, when seen through a magnifying glass, affords one of the finest sights that can be imagined.

CURCUMA, in botany, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: stamens four, barren, a fifth fertile; corolla four parted; nectary three-lobed; filament flat. There are three species, of which C. rotundo, round rooted turmerick has a perennial root, with a large ovate bulb, frequently as big as a goose's egg, covered with a thin pelicle, that has parallel rooting rings within, solid, fleshy, reddish yellow, of a bitterish taste, and slightly aromatic smell. Native of the East Indies, the mountains of China, Cochinchina, &c.

CURFEW, a signal given in cities, taken in war, &c. to the inhabitants to go to bed, advertise the people, to secure themselves from the robberies and debaucheries of the night.

The most eminent curfew in England, was that established by William the Conqueror, who appointed, under severe penalties, that, at the ringing of a bell, at eight o'clock in the evening, every one should put out their lights and fires, and go to bed: whence to this day, a bell, rung about that time, is called a curfew-bell.

CURRANS, or CURRANTS. See GROSSULARIA.

CURRENT is a term used to express the present time: thus, the year 1808 is the current year; the 20th current is the 20th day of the present month. The price current is the known and ordinary price accustomed to be given for it. As applied to commerce, we say, "current coin," for the known and common coin of the country.

CURRENT, in hydrography, a stream or flux of water in any direction. In the sea, they are either natural, occasioned by the diurnal motion of the earth round its axis, or accidental, caused by the water's being driven against promontories, or into gulfs and streights, where wanting room to spread they are driven back, and thus disturb the ordinary flux of the sea.

CURRENTS, in navigation, are certain settings of the stream, by which ships are compelled to alter their course or velocity, or both, and submit to the motion impressed upon them by the current. See HYDROGRAPHY.

CURRYING is the art of dressing cow-hides, calves-skins, seal-skins, &c., principally for shoes; and this is done either upon the flesh or the grain.

In dressing leather for shoes upon the flesh, the first operation is soaking the leather in water, until it is thoroughly wet; then the flesh side is shaved on a beam about seven or eight inches broad, with a knife of a peculiar construction, to a proper substance, according to the custom of the country, and the uses to which it is to be applied. This is one of the most curious and laborious operations in the whole mystery of currying. The knife used for this purpose is of a rectangular form, with two handles, one at each end, and a double edge. They are manufactured at Ci-

rencester, and composed of iron and steel: the edge is given to them by rubbing them on a flat stone of a sharp gritty substance till it comes to a kind of wire; this wire is taken off by a fine stone, and the edge is then turned to a kind of groove wire by a piece of steel in form of a bodkin, which steel is used to renew the edge in the operation.

After the leather is properly shaved, it is thrown into the water again, and scowered upon a board or stone commonly appropriated to that use. Scowering is performed by rubbing the grain or hair side with a piece of pumice-stone, or with some other stone of a good grit, not unlike in thickness and shape to the slate with which some houses are covered. These stones force out of the leather a white sort of substance, called the bloom, produced by the oak bark in tanning. The hide or skin is then conveyed to the shade or drying place, where the oily substances are applied, termed stuffing or dubbing. The oil used for this purpose is prepared by the oil leather dressers, by boiling sheep skins or doe skins in cod oil. This is put on both sides of the leather, but in greater and thicker quantity on the flesh than on the grain or hair side.

Thus we have pursued the currying of leather in its wet state, and through its first stage, commonly called getting out.

When it is thoroughly dry, an instrument, with teeth on the under side, called a graining-board, is first applied to the flesh-side, which is called graining; then to the grain-side called bruising. The whole of this operation is intended to soften the leather to which it is applied. Whitening, or pairing, succeeds, which is performed with a fine edge to the knife already described, and used in taking off the grease from the flesh. It is then boarded up, or grained again, by applying the graining-board first to the grain and then to the flesh.

It is now fit for waxing, which is performed first by colouring. This is performed by rubbing with a brush, dipped in a composition of oil and lamp black, on the flesh till it be thoroughly black: it is then sized, called black sizing, with a brush or spunge, dried, tallowed with a woollen cloth, and slicked upon the flesh with a small smooth piece of glass; sized again with a sponge; and when dry, this sort of leather, called waxed, or black on the flesh, is curried.

Currying leather on the hair or grain side, called black on the grain, is the same in the first operation with that dressed on the flesh, till it is scowered. Then the first black is applied to it while wet; which black is a solution of the sulphate of iron, called copperas, in fair water, or in the water in which the skins as they come from the tanner have been soaked: this is first put upon the grain after it has been rubbed with a stone: then rubbed over with a brush dipped in stale urine; slicked out with an iron slicker, in order to make the grain come out as fine as possible, and then stuffed in the manner already described among the first operations of currying; and when dry it is seasoned, *i. e.* rubbed over with a brush dipped in copperas water on the grain till it is perfectly black; then slicked with a stone of a good grit, to take out the wrinkles as much as possible: after this the grain is raised with a fine graining-board, by turning the skin or piece of leather in various directions; and when a little dried, it is bruised, in order to soften it. When it is thoroughly dry it is whitened, bruised again, and grained in two or three different ways, and when oiled upon the grain with a mixture of oil and tallow it is finished.

Bull and cow hides are sometimes curried for the use of sadlers and collar-makers; but the principal operations are much the same as those we have already described. It should, however, be observed, that only a small portion of flesh is taken off from hides designed for these purposes. Hides for the roofs of coaches, &c. are shaved nearly as thin as shoe hides, and blacked on the grain side.

The oil used in the first operation of stuffing, or dubbing, is called spent oil, and contains a portion of alkali. It has latterly been made up expressly for the curriers. A fact worthy of remark is, that it is imbibed more uniformly and effectually by wet than by dry leather; and this no doubt arises from the gradual evaporation of the water, which gives place to the introduction of the oil by capillary attraction, whereas the air, if interspersed in the pores, would resist it.

CURSITOR, a clerk belonging to the Court of Chancery, whose business it is to make out original writs. In the statute 18 Edward III. they are called clerks of course, and are twenty-four in number, making a corporation of themselves. To each of them is allowed a division of certain counties, into which they issue out the original writs required by the subject.

CURSOR, in mathematical instruments,

is any small piece that slides, as the piece in an equinoctial ring-dial that slides to the day of the month; the little label of brass divided like a line of sines, and sliding in a groove along the middle of another label, representing the horizon in the analemma; and likewise a brass point screwed on the beam-compasses, which may be moved along the beam for the striking of greater or less circles.

CURTATE *distance*, in astronomy, the distance of a planet from the sun to that point where a perpendicular let fall from the planet meets with the ecliptic.

CURTATION, in astronomy, is the interval between a planet's distance from the sun, and the curtate distance.

CURTIN, CURTAIN, or COURTIN, in fortification, is that part of the rampart of a place which is betwixt the flanks of two bastions bordered with a parapet five feet high, behind which the soldiers stand to fire upon the covered way, and into the moat.

CURTISIA, in botany, so named from William Curtis, teacher of botany in London, author of "Flora Londinensis," a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-parted; petals four; drupe superior, roundish, succulent, with a four or five-celled nut. There is but one species, *viz.* C. faginea, beech-leaved Curtisia, or hassagay-tree. This is one of the largest trees in the African woods, with very diminutive flowers. The Hottentots and Caffres make the shafts of their javelins, or assagays, from the wood of this tree. They always carry one or two of these with them on their journies. They consist of an iron spear hollowed out on each side, about six inches long, with an iron shaft. It is fastened with thongs of leather to a slender round stick, five feet long, tapering towards the end. With these lances, which they throw with great dexterity to the distance of a hundred paces, the Hottentots and Caffres defend themselves, and kill buffaloes and other wild animals.

CURVATURE *of a line*, is the peculiar manner of its bending or flexure by which it becomes a curve of such and such peculiar properties. Any two arches of curve lines touch each other when the same right line is the tangent of both at the same point; but when they are applied upon each other in this manner, they never perfectly coincide, unless they are similar arches of equal and similar figures; and the curvature of lines admit of indefinite variety. Because the curvature is uniform in a given circle, and may be varied at pleasure in them, by enlarging or diminishing their diameters: the curvature of circles serves for measuring that of other lines.

Of all the circles that touch a curve in any given point, that is said to have the same curvature with it, which touches it so closely, that no circle can be drawn through the point of contact between them. And this circle is called the circle of curvature; its centre, the centre of curvature; and its semidiameter, the ray of curvature belonging to the point of contact. As in all figures, rectilinear ones excepted, the position of the tangent is continually varying; so the curvature is continually varying in all curvilinear figures, the circle only excepted. As the curve is separated from its tangent by its curvature, so it is separated from the circle of curvature in consequence of the increase or decrease of its curvature; and as its curvature is greater or less, according as it is more or less inflected from the tangent, so the variation of curvature is greater or less, according as it is more or less separated from the circle of curvature.

When any two curve lines touch each other in such a manner that no circle can pass between them, they must have the same curvature; for the circle that touches the one so closely that no circle can pass between them, must touch the other in the same manner. And it can be made appear, that circles may touch curve lines in this manner; that there may be indefinite degrees of more or less intimate contact between the curve and the circle of curvature; and that a conic section may be described that shall have the same curvature with a given line at a given point, and the same variation of a curvature, or a contact of the same kind with the circle of curvature. The rays of curvature of similar arches, in similar figures, are in the same ratio as any homologous lines of these figures, and the variation of curvature is the same. See CURVE.

CURVE, in geometry, a line which running on continually in all directions, may be cut by one right line in more points than one. Curves are divided into algebraical or geometrical and transcendental. Geometrical or algebraical curves are those whose ordinates and abscisses being right lines, the nature thereof can be expressed by a finite equation having those ordinates and abscisses in it.

Transcendental curve, is such as when expressed by an equation, one of the terms thereof is a variable quantity.

Geometrical lines or curves are divided into orders, according to the number of dimensions of the equation expressing the relation between the ordinates and abscisses, or according to the number of points by which they may be cut by a right line. So that a line of the first order will be only a right line expressed by the equation $y + a x + b = 0$. A line of the second, or quadratic order, will be the conic sections and circle whose most general equation is $y^2 + \overline{a x + b} \times y + c x^2 + d x + e = 0$. A line of the third order is that whose equation has three dimensions, or may be cut by a right line in three points, whose most general equation is $y^3 + \overline{a x + b} \times y^2 + \overline{c x^2 + d x + e} \times y + f x^3 + g x^2 + h x + k = 0$. A line of the fourth order, is that whose equation has four dimensions, or which may be cut in four points by a right line, whose most general equation is $y^4 + \overline{a x + b} \times y^3 + \overline{c x^2 + d x + e} \times y^2 + \overline{f x^3 + g x^2 + h x + k} \times y + l x^4 m x^3 + n x^2 + p x + q = 0$. And so on.

And a curve of the first kind (for a right line is not to be reckoned among curves) is the same with a line of the second order; and a curve of the second order, the same as a line of the third; and a line of an infinite order, is that which a right line can cut in an infinite number of points, such as a spiral, quadratrix, cycloid, the figures of the sines, tangents, secants, and every line which is generated by the infinite revolutions of a circle or wheel.

As to the curves of the second order, Sir Isaac Newton observes they have parts and properties similar to those of the first: thus as the conic sections have diameters and axes, the lines cut by these are called ordinates, and the intersection of the curve and diameter, the vertex; so in curves of the second order, any two parallel lines being drawn so as to meet the curve in three points, a right line cutting these parallels so as that the sum of the two parts between the secant and the curve on one side is equal to the third part terminated by the curve on the other side, will cut in the same manner all other right lines parallel to these, and meet the curve in three parts, so as that the sum of the two parts on one side will be still equal to the third part on the other side.

These three parts, therefore, thus equal, may be called ordinates or applicates: the secant may be stiled the diameter; the intersection of the diameter and the curve the vertex; and the point of concourse of any two diameters the centre. And if the diameter be normal to the ordinates, it may be called axis; and that point where all the diameters terminate the general centre. Again, as an hyperbola of the first order has two assymptotes; that of the second three; that of the third four, &c.: and as the parts of any right line lying between the conic hyperbola and its two assymptotes are every where equal; so in the hyperbola of the second order, if any right line be drawn cutting both the curve and its three assymptotes in three points, the sum of the two parts of that right line being drawn the same way from any two assymptotes to two points of the curve, will be equal to a third part drawn a contrary way from the third assymptote to a third point of the curve. Again, as in conic sections not parabolical, the square of the ordinate, that is the rectangle under the ordinates drawn to contrary sides of the diameter, is to the rectangle of the parts of the diameter which are terminated at the vertices of the ellipsis or hyperbola, as the latus rectum is to the latus transversum; so in non-parabolic curves of the second order, a parallelopiped under the three ordinates is to a parallelopiped under the parts of the diameter, terminated at the ordinates, and the three vertices of the figure, in a certain given ratio; in which ratio, if you take three right lines situated at the three parts of the diameter between the vertices of the figure, one answering to another, then these three right lines may be called the latera recta of the figure, and the parts of the diameter, between the vertices, the latera transversa. And as in the conic parabola, having to one and the same diameter but one only vertex, the rectangle under the ordinates is equal to that under the part of the diameter cut off between the ordinates and the vertex, and the latus rectum; so in curves of the second order, which have but two vertices to the same diameter, the parallelopiped under three ordinates, is equal to the parallelopiped under the two parts of the diameter, cut off between the ordinates and those two vertices and a given right line, which therefore may be called the latus rectum. Moreover, as in the conic sections, when two parallels terminated on each side of the curve are cut by two other parallels terminated on each by the curve, the first by the

third, and the second by the fourth; as here the rectangle under the parts of the first is to the rectangle under the parts of the third; as the rectangle under the parts of the second is to that under the parts of the fourth; so when four such right lines occur in a curve of the second kind, each in three points, then shall the parallelopiped under the parts of the first right line, be to that under the parts of the third; as the parallelopiped under the parts of the second line, to that under the parts of the fourth. Lastly, the legs of curves, both of the first, second, and higher kinds, are either of the parabolic or hyperbolic kind: an hyperbolic leg being that which approaches infinitely towards some assymptote; a parabolic that which has no assymptote. These legs are best distinguished by their tangents; for if the point of contact go off to an infinite distance, the tangent of the hyperbolic leg will coincide with the assymptote; and that of the parabolic leg recede infinitely and vanish. The assymptote, therefore, of any leg is found by seeking the tangent of that leg to a point infinitely distant; and the bearing of an infinite leg is found by seeking the position of a right line parallel to the tangent, when the point of contact is infinitely remote: for this line tends the same way towards which the infinite leg is directed. For the other properties of curves of the second order, we refer the reader to Mr. Maclaurin's treatise "De Linearum geometricarum Proprietatibus generalibus."

Sir Isaac Newton reduces all curves of the second order to the four following particular equations, still expressing them all. In the first, the relation between the ordinate and the abscisse, making the abscisse x and the ordinate y, assumes this form $xy^2 + ey = ax^3 + bx^2 + cx + d$. In the second case, the equation takes this form $xy = ax^3 + bx^2 + cx + d$. In the third case, the equation is $y^2 = ax^3 + bx^2 + cx + d$. And in the fourth case the equation is of this form, $y = ax^3 + bx^2 + cx + d$. Under these four cases the same author enumerates seventy-two different forms of curves, to which he gives different names, as ambigenal, cuspidated, nodated, &c.

Curves, *genesis of, of the second order by shadows.* If (says Sir Isaac Newton) upon an infinite plane illuminated from a lucid point the shadows of figures be projected, the shadows of the conic sections will be always conic sections; those of the curves of the second kind will be always curves of the second kind; those of the curves of the third kind will be always curves of the third kind, and so on *in infinitum.* And as a circle by projecting its shadow generates all the conic sections, so the five diverging parabolas by their shadows will generate and exhibit all the rest of the curves of the second kind: and so some of the most simple curves of the other kinds may be found which will form by their shadows upon a plane, projecting from a lucid point, all the rest of the curves of that same kind.

Curves *of the second order having double points.* As curves of the second order may be cut by a right line in three points; and as two of these points are sometimes coincident, these coincident intersections, whether at a finite or an infinite distance, are called the double point.

Curves, *use of, in the construction of equations.* One great use of curves in geometry is, by means of their intersections, to give the solution of problems. See Equations.

Suppose, *ex. gr.* it were required to construct the following equation of 9 dimensions,

$x^9 + bx^7 + cx^6 + dx^5 + ex^4 + \overline{m+f}.x^3 + gx^2 + hx + k = 0$: assume the equation to a cubic parabola $x^3 = y$; then, by writing y for x^3, the given equation will become $y^3 + bxy^2 + ey^2 + dx^2y + cxy + my + fx^3 + gx^2 + hx + k = 0$; an equation to another curve of the second kind, where m or f may be assumed $= 0$, or any thing else: and by the descriptions and intersections of these curves will be given the roots of the equation to be constructed. It is sufficient to describe the cubic parabola once. When the equation to be constructed, by omitting the two last terms hx and k, is reduced to 7 dimensions; the other curve, by expunging m, will have the double point in the beginning of the absciss, and may be easily described as above: if it be reduced to 6 dimensions, by omitting the last three terms, $gx^2 + hx + k$; the other curve, by expunging f, will become a conic section. And if, by omitting the last three terms, the equation be reduced to 3 dimensions, we shall fall upon Wallis's construction by the cubic parabola and right line.

Curves, *family of,* according to Wolfius, is a congeries of several curves of different kinds, all defined by the same equation of an indeterminate degree; but differently, according to the diversity of their kinds.

For example, let the equation of an indeterminate degree be $a^{m-1}x = y^m$. If $m = 2$, ax will be equal to y^2. If $m = 3$, then will $a^2x = y^3$. If $m = 4$, then will $a^3x = y^4$, &c.; all which curves are said to be of the same family. The equations, however, by which the families of curves are defined, must not be confounded with transcendental ones; though with regard to the whole family they be of an indeterminate degree, yet with respect to each several curve of the family they are determinate; whereas transcendental equations are of an indefinite degree with respect to the same curve.

CUSCUTA, in botany, a genus of the Tetrandria Digynia class and order. Natural order of Convolvuli. Essential character: calyx four-cleft; corolla one-petalled; capsule two-celled. There are four species. These are parasitical plants, fastening themselves to, and drawing their nourishment from others. C. Europæa, common dodder, is a native of Europe, in the hedges, &c. usually on bushes and the loftier plants, as hops, brambles, woody nightshade, fern, thistles, hemp; also on flax, nettles, clover grass, &c. flowering in July and August.

CUSSONIA, in botany, so called in memory of Cusson, a celebrated botanist; genus of the Pentandria Digynia class and order. Natural order of Araliæ. Essential character: petals three-cornered; margin of the receptacle dilated into a five-toothed calyx. There are two species, *viz.* C. thysiflora and C. spicata, both natives of the Cape of Good Hope.

CUSTOM, a very comprehensive term, denoting the manners, ceremonies, and fashions of a people, which having turned into a habit, and passed into use, obtains the force of laws; in which sense it implies such usages as, though voluntary at first, are yet, by practice, become necessary.

Custom is hence, both by lawyers and civilians, defined *lex non scripta*, a law, or right, not written, established by long usage, and the consent of our ancestors; in which sense it stands opposed to the *lex scripta*, or the written law.

As no law can bind people without their consent, so, wherever that is had, and a certain rule used as a law, such rule gives it the force of a law; and if it be universal, then it is common law; but if restrained to this or that particular place, it is custom.

Custom had its beginning, and received the sanction of the law, thus: when a reasonable act, once done, was found to be beneficial to the people, then they had frequent recourse to it; and by repetitions thereof, it became a custom, which being continued *ultra tritavum*, time out of mind, without any interruption, it obtained the power of a law, and binds the places, persons, and things concerned therein.

All customs ought to have a reasonable commencement, be certain, not ambiguous, have uninterrupted continuance, and not be against the King's prerogative: these are incidents inseparable: yet a custom is not unreasonable for being injurious to private persons and interest, so as it tends to the general advantage of the people: but if any custom be contrary to the public good, or if it injures a multitude, and benefits only some certain persons, such a custom is repugnant to the laws of reason, and consequently void. Custom must always be alleged in many persons; and so it may be claimed by copyholders, or the inhabitants of a place, as within such a county, hundred, city, borough, manor, parish, &c. but regularly they shall not allege a custom against a statute: nor may custom be pleaded against custom; though acts of parliament do not always take away the force of customs. The general customs used throughout England being the common law, are to be determined by the judges, who can over-rule a custom that is against natural reason, &c.; but particular customs are determinable by jury. See PRESCRIPTION.

CUSTOM *of London.* It is a custom of London, that where a person is educated in one trade, he may set up another; that where a woman uses a trade without her husband, she is chargeable alone, as a *feme sole* merchant, and, if condemned, shall be put in prison till she pays the debt; likewise the bail for her are liable if she absent herself, and the husband, in these cases, shall not be charged. If a debtor be a fugitive, by the custom of London he may be arrested before the day, in order to find better security, &c. These are customs of this city, different from those of other places.

CUSTOM *of merchants.* If a merchant gives a character of a stranger to one who sells him goods, he may be obliged to satisfy the debt of the stranger for the goods sold, by the custom of merchants. And when two persons are found in arrears, upon an account grounded on the custom of merchants, either of them may be charged to pay the whole sum due, &c.

CUSTOMS, in commerce, the duties or taxes payable upon the importation or exportation of merchandise. They appear to have been originally levied to reimburse the sovereign for the expense he incurred in protecting foreign trade, and were considered as taxes upon the profits of the merchants, being imposed equally upon all sorts of goods, necessaries as well as luxuries, goods exported as well as goods imported; but at a higher rate on the goods of aliens than on such as belonged to the merchants of the country.

The customs of England appear to have originated from the ancient claim of purveyance and pre-emption, or the right of buying by the intervention of the King's purveyors, for the use of the royal household, at an appraised valuation, in preference to all other persons, and even without the consent of the owner; this claim being extended to goods imported from foreign parts was called prisage, and was levied by taking a determined part of the goods for the King's use, at a price to be set by the King, and called the King's price, which was always lower than the current price. Wine being the principal article of foreign produce then in request, was the chief object of this duty, and the claim was two tons from every ship laden with twenty tons or more, one to be taken before, and the other behind the mast. A small duty of two shillings for every ton of wine imported by merchant strangers was called butlerage, from being paid to the King's chief butler.

From the charta mercatoria of Edw. I. granted in 1304, it appears, that there were known and established customs or duties long before that time, both on importation and exportation, as the duties then imposed were to be paid over and above the old customs; which, with respect to wool, the principal article of export was six shillings and eight pence for every sack, and the new duty three shillings and four pence. In the year 1354 the whole revenue arising from the customs of England was 82,426*l.* 18*s.* 10*d.* of which the duties on the imported goods amounted to only 580*l.* 6*s.* 8*d.* Nearly the whole of the export duties was levied on wools and woolfells, and as the duties on wool thus formed one of the chief branches of the revenue of the crown, the exportation of this important material was encouraged in order to augment the produce of the customs.

The ancient customs of England have usually been divided into three branches. 1. The duties upon wool and leather. 2. The duty upon wine, which being imposed at so much per ton, was called a tonnage. 3. A duty upon all other goods, which, being imposed at so much in the pound of their supposed value was called a poundage. The first branch declined when the woollen manufacture began to make some progress in this country, and has since wholly ceased from the prohibition of the exportation of wool. The other two branches were usually granted by the same act of parliament, and were called the subsidy of tonnage and poundage. The subsidy of poundage having continued for a long period at one shilling in the pound, or at five per cent. a subsidy became the general denomination for a custom duty at this rate per cent. The original subsidy was levied according to a book of rates established in the 12th year of Charles II. and was called the old subsidy, to distinguish it from the subsidy of tonnage and poundage imposed in 1698. Other subsidies were imposed at subsequent periods, differing from the old subsidy only in being laid almost wholly on goods imported, whereas that included both imports and exports.

The introduction of the funding system occasioned very frequent impositions of new and additional duties, which were generally adjusted on the principles of the old subsidy; that is, the value of the goods was ascertained by a book of rates, and the amount computed by the quantities of the goods, either with respect to gage, to weight, or to tale; the duty, therefore, was not a certain proportion of their real value, but of an arbitrary value, agreeing perhaps with the current value at the time of imposing the duty, but which, from the natural fluctuations of trade and manufactures, must necessarily be liable to many changes and alterations. There was also another mode by which duties were imposed, this was by a proportion to the value, on goods not rated, being levied according to the actual value of the same as sworn to by the importers. These principles being once adopted, were followed in all the new and additional duties of customs which were imposed for payment of the interest on the various loans which were raised from time to time for the public service. In some instances the additional duties were calculated by a per centage on the duties previously paid; in others a further duty was laid on a different denomination of the commodity, or

ther with respect to its value, its bulk, its weight, or its number; and by proceeding repeatedly in this manner, the numerous additions made at length became such a mass of confusion as produced an infinity of inconvenience and delay in business, and became the subject of universal complaint among mercantile persons. From the great complexity of the whole of this branch of the revenue, arising from the multiplicity of duties, which, being appropriated to separate funds, were obliged to be kept distinct, scarcely any merchant could ascertain, by calculations of his own, the duties he was to pay, but was left in a great measure at the mercy of the officers of the customs, who from being intended as a check upon the merchants, thus became their agents.

The Commissioners of Accounts, appointed in the year 1780, in their 13th, 14th, and 15th, reports, the last of which was dated 19th December 1786, have given a full explanation of the constitution of this department of the revenue, the duties of its several officers, and the mode of collecting it both in London and the out-ports. They also pointed out a variety of important regulations for retrenchment of expense, reduction of the establishment, and accommodation of the merchants, most of which have since been carried into effect. But the most extensive and useful measure recommended by them was a consolidation of all the existing duties, by the substitution of one single duty on each article, amounting as nearly as possible to the aggegate of all the various duties then payable. This was effected in 1787 by an act 27 Geo. III. cap. 13, by which the accounts of the customhouse were much simplified, and the rates of duty rendered intelligible to all persons affected by them.

In the year 1797 eight new branches of duties had been created since the consolidation, which made it necessary to keep so many new and distinct accounts. At this time the number of articles subject to the custom duties amounted to not less than 1200, not more than 160 of which appear upon the annual accounts presented to parliament, as yielding the sum of 1000*l.* and upwards; the remaining 1040 are classed together under the general head of "sundry small articles," and did not produce, in the whole, more than from 85,000*l.* to 110,000*l.* per annum; each of these articles, nevertheless, had some special regulation belonging to it, and the accumulated mass of these details had, in the opinion of the Select Committee on Finance, rendered the whole system much too complex. That this opinion was well founded will be admitted from the circumstance, that the statutes relative to the customs, alone, make six very large volumes in folio.

In the year 1803 the customs were again consolidated by 43 Geo. III. cap. 68; but additional duties have been since imposed, which will render it necessary to have recourse again to this useful measure at a future period.

Total gross receipt of the Customs of Great Britain, in the year ending 5th of January, 1807, with the payments to which it was subject, and the nett amount paid into the Exchequer.

	£.	s.	d.
Balance in the hands of the different Collectors on the 5th of January, 1806	50,843	16	3
Balance in the hands of the Receiver General of Scotland	54,657	3	8½
Bills arising and remitted out of the revenue of 1805, but not brought to account till 1806	283,759	1	3¾
Gross receipt of permanent and temporary duties within the year	12,379,983	19	1¼
Total	£12,769,244	0	4½

	£.	s.	d.
Paid drawbacks, repayments, on over-entries, and bounties of the nature of drawbacks	1,560,346	11	8¼
Bounties for promoting national objects	307,864	3	1¼
Money imprest in the hands of out-port collectors, &c.	34,989	13	3
Paid towards the expenses of the civil government of Scotland	76,445	18	6½
Charges of management	655,603	8	10½
Payments into the Exchequer	9,733,813	12	1½
Balance in the hands of the different collectors on the 5th of January, 1807	58,594	11	6½
Balance in the hands of the Receiver General of Scotland on the 5th of January, 1807	61,542	8	7½
Bills arising and remitted out of the revenue of 1806, but not brought to account till 1807	280,043	12	7½
Total	£12,769,244	0	4½

Deducting from the gross receipt of 12,379,983*l.* 19*s.* 1¼*d.* the amount paid for drawbacks on exportation, and in bounties for promoting national objects, being 469,983*l.* 14*s.* 2*d.*; the total nett produce of the year will be 11,910,000*l.* 4*s.* 11¼*d.* which arose as follows:

	£.	s.	d.
From duties inwards	10,166,561	13	4¾
——— outwards	621,566	16	5¼
——— coastways	1,035,988	17	8
——— remittances from the plantations, quarantine duty, &c.	85,882	17	5¼
Total	£11,910,000	4	11¼

The total expense of collecting the customs of Great Britain was, in the year 1795, at the rate of 6*l.* 19*s.* 5*d.* per cent. on the gross receipt, or 10*l.* 3*s.* 5*d.* per cent. on the nett produce; but in consequence of the various regulations which have since been adopted, the expense of the collection has been considerably reduced. In the year ending the 5th of January, 1807, it amounted to 5*l.* 2*s.* 8*d.* per cent. on the gross receipt, or 6*l.* 4*s.* 3*d.* per cent. on the nett produce.

CUSTOS *brevium*, the principal clerk belonging to the court of common pleas, whose business is to receive and keep all the writs made returnable in that court, filing every return by itself; and, at the end of each term, to receive of the prothonotaries all the records of the nisi prius, called the posteas. The posteas are first brought in by the clerks of assize of every circuit to that prothonotary who entered the issue in the causes, in order to enter judgment; and after the prothonotary has entered the verdict and judgment thereupon into the rolls of the court, he delivers them over to the custos brevium, who binds them into a bundle. The custos brevium makes likewise entries of writs of covenant, and the concord upon every fine: by him also are made out exemplifications and copies of all writs and records in his office, and of all fines levied, which being engrossed, are divided between him and the chirographer, which last keeps the writ of covenant and the note; and the former the concord and foot of the fine. The custos brevium is made by the king's letters patent.

Custos *rotulorum*, an officer who has the custody of the rolls and records of the sessions of peace, and also of the commission of the peace itself. He usually is some person of quality, and always a justice of the peace, of the quorum, in the county where he is appointed. This officer is made by writing under the king's sign manual, being the Lord Chancellor's warrant to put him in commission. He may execute his office by a deputy, and is empowered to appoint the clerk of the peace, but he may not sell the place on divers penalties.

CUTICLE, *cuticula*, in anatomy, a thin membrane, closely lying upon the skin or

cutis, of which it seems a part, and to which it adheres very firmly, being assisted by the intervention of the corpus reticulare.

CUTIS, the skin, in anatomy, is that strong covering which envelopes the whole external surface of animals. It is composed chiefly of a thin white elastic layer on the outside, called the epidermis or cuticle, and a thicker layer, composed of fibres thickly interwoven, and disposed in different directions, which is the cutis or real skin. The epidermis is that part of the skin which is raised in blisters. This is readily separated from the cutis by maceration in hot water. It is very elastic and insoluble in water and alcohol. Pure fixed alkalies and lime dissolve it entirely. Mr. Hatchet, from many experiments, has shewn that the epidermis resembles albumen in many of its properties, or rather that it is nothing more than a peculiar modification of coagulated albumen. The cutis is a thick dense membrane, composed of fibres interwoven like the texture of a hat. When it is macerated some hours in water, and agitation and pressure are employed to accelerate the effect, the blood, and all the extraneous matter with which it was loaded, are separated from it, but its texture remains unaltered. On evaporating the water employed, a small quantity of gelatine may be obtained. No subsequent maceration in cold water has any farther effect. When distilled it yields the same products as fibrin. The concentrated alkalies dissolve it, converting it into oil and ammonia. Weak acids soften it, render it transparent, and at last dissolve it. Nitric acid converts it into oxalic acid and fat, while, at the same time, azotic gas and prussic acid are emitted. When heated it contracts, and then swells, exhales a fetid odour, and leaves a dense charcoal, difficult to incinerate. By spontaneous decomposition in water or moist earth, it is converted into a fatty matter, and into ammonia, which compose a kind of soap. When allowed to remain long in water, it softens and putrefies, being converted into a kind of jelly. When long boiled in water it becomes gelatinous, and dissolves completely, constituting a viscid liquor, which, by proper evaporation is converted into glue. Hence the cutis of animals is commonly employed in the manufacture of glue.

From these facts the cutis appears to be a peculiar modification of gelatine enabled to resist the action of water, partly by the compactness of its texture, and partly by the viscidity of the gelatine of which it is formed; for those skins which dissolve most readily in boiling water afford the worst glue. The skin of the eel is very flexible, and affords very readily a great proportion of gelatine. The skin of the shark also readily yields abundance of gelatine; and the same remark applies to the skins of the hare, rabbit, calf, and ox; the difficulty of obtaining the glue and its goodness always increasing with the toughness of the hide. The hide of the rhinoceros, which is exceedingly strong and tough, far surpasses the rest in the difficulty of solution, and in the goodness of its glue. When skins are boiled, they gradually swell and assume the appearance of horn; then they dissolve slowly.

CUTLERY. Though cutlery in the general sense comprises all those articles denominated edge-tools, it is more particularly confined to the manufacture of knives, forks, scissars, penknives, razors, and swords. Damascus was anciently famed for its razors, sabres, and swords. The latter are said to possess all the advantages of flexibility, elasticity, and hardness. These united distinctions are said to have been effected by blending alternate portions of iron and steel, in such a manner, that the softness and tenacity of the former could prevent the breaking of the latter.

The Germans, it appears, were acquainted with the art of making various cutlery, previous to such manufacture being known in this country. The steel employed for cutlery in Germany, is immediatly made from the crude iron into bars, without requiring afterwards to be converted. It is generally of great tenacity, but does not take a good polish, and in consequence has been long superseded by the artificial steel of this country, made from the bar-iron of Sweden and Russia.

All those articles of cutlery which do not require a fine polish, and are of low price, are made from blistered steel. Those articles which require the edge to possess great tenacity, at the same time that superior hardness is not required, are made from sheer-steel. The finer kinds of cutlery are made from steel which has been in a state of fusion, and which is termed cast steel, no other kinds being susceptible of a fine polish. See the article Steel.

Table knives are mostly made of sheer-steel, the tang and shoulder, or bolster, being of iron, the blade part being attached by giving them a welding heat. The knives after forging are hardened by heat,

ing them red hot and plunging them into water; they are afterwards heated over the fire till they become blue; they are then ground upon stones of large diameter for the purpose of making their sides flat, since it is the disposition of small stones to make the sides concave. The blades are finished upon an instrument called a glazor, which consists of a circular piece of wood covered with leather, and coated with glue and emery. The handles of table knives are made of ivory, plassed horn, bone, stag horn, and wood, into which the blades are cemented with resin and pulverized brick, and for ivory, instead of the latter, whitening.

Forks are made almost altogether by the aid of the stamp and appropriate dies. The prongs only are hardened and tempered, by a method similar to that employed for the knives, being required of about the same degree of hardness.

The shank and bosom of the fork are ground upon a thin stone, which is round upon the face; it is of very rough and open texture and is employed in the dry state. The prongs are ground upon a stone which is broad and flat upon the face; they are finished upon glazors coated with emery and glue; the insides of the prongs are dressed by means of a thin leathern strap, coated with glue and emery; for this purpose the fork is placed in an horizontal position, and the strap drawn backward and forward. Silver forks are a distinct branch of manufacture, being confined to the silversmiths: they are cast into moulds of fine sand, and finished in a manner similar to that of other silver goods.

Razors. Almost all razors are made of cast steel, the quality of which should be very good; the edge of a razor requiring the combined advantages of great hardness and tenacity. After the razor blade is forged, it is hardened by gradually heating it to bright red heat, and plunging it into cold water. It is tempered by heating it afterwards till a brightened part appears of a straw colour. Though this is generally performed by placing them upon the open fire, it would be more equally effected by sand, or what is still better, in hot oil, or fusible mixture, consisting of eight parts of bismuth, five of lead, and three of tin. A thermometer being placed in the liquid at the time the razors are immersed for the purpose of indicating the proper temperature, which is about 500 of Fahrenheit. Razors are ground crosswise upon stones, from four to seven inches in diameter, a small stone being necessary to make the sides concave. Razors having the concave form, have been thought to shave with more facility, but if it be remarked that the canal formed by honing the razors, is a portion of a wedge, the length of which is equal to the breadth of the razor, and of a thickness equal to that of the back, it will be readily seen that the concave form can not possess any other advantage, than that of saving time in sharpening the razor, owing to the small surface exposed to the action of the hone or the strap. After the razor has been ground into its proper shape, it is finished by two processes, one called laping, or glazing, and the other polishing. The lap, or glazor, is formed of wood faced with an alloy of lead and tin; after its face is turned to the proper form and size, it is filled with notches, which are filled up with emery and tallow. This instrument gives to the razor a smooth and uniform surface, and consequently a fine edge. The last process is that of polishing; the polisher consists of a piece of circular wood running upon an axis, like that of the stone or the glazor. It is coated with leather, having from time to time its surface covered with crocus martis. The surface of the polisher when in motion, moves at the rate of 75 feet in a second. This is slow when compared with the velocity of the stone and the glazor. The surface of the former moving at the rate of 576 feet in a second, and the latter with about twice that velocity. The handles of high priced razors are made of ivory and tortoiseshell, but in general they are of polished horn, which are prefered on account of their cheapness and durability. The horn is cut into pieces and placed between two corresponding dies, having a recess of the shape of the handle. The dies are previously heated to about 500° of Fahrenheit, and placed with the horn in a process of such power, that allowing the man's strength to be 200*lb*. it will be equal to 43000*lb*. By this process the horn admits of considerable extension; if the horn is not previously black, the handles are dyed black by means of a bathe of logwood and green vitriol. They afterwards require to be dressed first with sand and water, and lastly upon a buff, which is a species of glazor covered upon the face with buff leather, and smeared over with rotten-stone and oil.

The clear horn handles are sometimes stained so as to imitate the tortoiseshell;

this is effected by laying upon the handle a composition of three parts of potash, one of minium, ten of quick-lime, and as much water as will make the whole into a pulpy mass. Those parts of the handle requiring darker shades, are covered thicker than the other. After this substance is laid upon the handles, they are placed before the fire for a few hours, the time requisite for giving the proper effect.

Penknives. The manufacture of penknives is divided into three departments, the first is the forging of the blades, the spring, and the iron scales; the second, the grinding and polishing of the blades; and the third, the handling, which consists in fitting up all the parts and finishing the knife. The blades are made of the best cast steel, and hardened and tempered to about the same degree with that of razors. In grinding they are made a little more concave on one side than the other; in other respects they are treated in a similar way to razors. The handles are covered with horn, ivory, and sometimes wood, but the most durable are those of stag-horn. The most general fault in penknives is that of being too soft. The temper ought to be not higher than a straw colour, as it seldom happens that a penknife is so hard as to snap on the edge.

Scissars. The beauty and elegance of polished steel is not displayed to more advantage than in the manufacture of the finer kinds of scissars. The steel employed for the more valuable scissars should be cast steel of the choicest qualities; it must possess hardness and uniformity of texture for the sake of assuming a fine polish, great tenacity when hot for the purpose of forming the bow or ring of the scissar, which requires to be extended from a solid piece, having a hole previously punched through it. It ought also to be very tenacious when cold, to allow that delicacy of form observed in those scissars termed ladies scissars. After the scissars are forged as near to the same size as the eye of the workmen can ascertain, they are paired, and the two sides fitted together. The bows and some other parts are filed to their intended form, the blades are also roughly ground, and the two sides properly adjusted to each other after being bound together with wire and hardened up to the bows. They are afterwards heated till they become of a purple colour, which indicates their proper temper. Almost all the remaining part of the work is performed at the grinding mill, with the stone, the lap, the polisher, and the brush. The latter consists of a circular piece of wood fitted upon an axis, and set upon the face with very strong bristles. It is used to polish those parts which have been filed, and which the lap and the polisher cannot touch. Previous to screwing the scissars together for the last time, they are rubbed over with the powder of quick-lime, and afterwards wiped clean with a skin of soft sheep leather. The quick-lime absorbs the moisture from the surface to which the rusting of steel is justly attributed. Scissars are frequently beautifully ornamented by blueing and gilding, and also with studs of gold or polished steel. They are at present most elegantly ornamented by the gold being inlaid on a level with the surface of the steel, the gold surface being afterwards increased. The very large scissars are partly of iron and partly of steel, the shanks and bows being of the former. These, as well as those all of steel which are not hardened all over cannot be polished, an inferior sort of lustre, however, is given to them by means of a burnish of hardened polished steel, which is very easily distinguished from the real polish by the irregularity of the surface. (For swords, see SWORD.)

Casting of Cutlery. From the great alliance of pig-iron to steel, it has been long thought practicable to cast the steel into the articles required, and by that means save all the expence of forging, and at the same time make the articles much nearer their intended form than could possibly be done by the hammer. The steel in its perfect state is, however, incapable of this advantage, though when in a state of fusion it is capable of being cast into large ingots. It is so imperfectly liquid at that temperature as to preclude the possibility of casting it into articles so small as knives or scissars. That species of pig-iron called N°. 1, is susceptible of so perfect a liquidity as to be cast into needles and fish-hooks, and has been employed for making a great variety of cutlery, particularly forks and scissars. Immediately after the articles are cast, which is generally into wet sand, they are as brittle as glass, and in that state could not be used for any purpose. By being stratified with sand, and kept at a red heat for 24 hours, they assume a degree of softness and tenacity, which will allow them to bend to a considerable angle. This process is called annealing. This branch of

manufacture has of late undergone very considerable improvement, by an invention of Mr. Lucas of Sheffield, for which he has obtained a patent. The articles are cast of the most fusible pig-iron, and are afterwards converted into a state of steel by cementation. The pig-iron which only differs from steel in containing an excess of carbon, is stratified in close vessels, with some substance capable of furnishing oxygen, with which the carbon of the pig-iron combines, forming carbonic acid, which escapes in the form of gas. See the article STEEL.

CUTTER, in naval affairs, a small vessel commonly navigated in the channels of England, furnished with one mast and a straight running bowsprit, or which can be run in on deck occasionally; except which, and the largeness of the sails, they are rigged much like sloops.

CUTTLE FISH. See SEPIA.

CYANELLA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla six-petalled; the three lower petals hanging forwards; stamens lower declined, longer than the rest. There are three species, natives of the Cape.

CYATHEA, in botany, a genus of the Cryptogamia Filices class and order. Fructification in roundish scattered dots, seated on a columnar receptacle, within the calyx-like involucre which opens at top; there are about nine species.

CYATHUS, in botany, a genus of the Cryptogamia Fungi: fungus campanulate or cylindrical, bearing lentiform capsules within. There are six species.

CYCAS, in botany, a genus of the Dioecia Polyandria class and order. Natural order of Palms. Filices, or Ferns, Jussieu. Essential character: male, ament-strobile form, with the scales covered every where beneath with pollen. Female, spadix sword-form; germ immersed into the corners of it solitary; style one; drupe with a woody nut. There are two species, *viz.* C. circinalis, broad-leaved cycas, and C. revoluta, narrow-leaved cycas. The first is a native of the Cape, the other of China, where it is cultivated for its beauty.

CYCLAMEN, in botany, English cyclamen, or sow-bread, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla rotate, reflex, with a very short tube and prominent throat; berry covered with a capsule. According to Martyn there are five species. Linnæus reckons two. Millar and Parkinson make eight and ten. The flowers are borne singly on a naked stem, peduncle or scape, and are nodding. The root is roundish, solid, and tuberous. Linnæus observes, that the several varieties connect the plants which have angular leaves with those which have round ones, so intimately that limits are assigned to them with difficulty. They are most of them natives of the South of Europe.

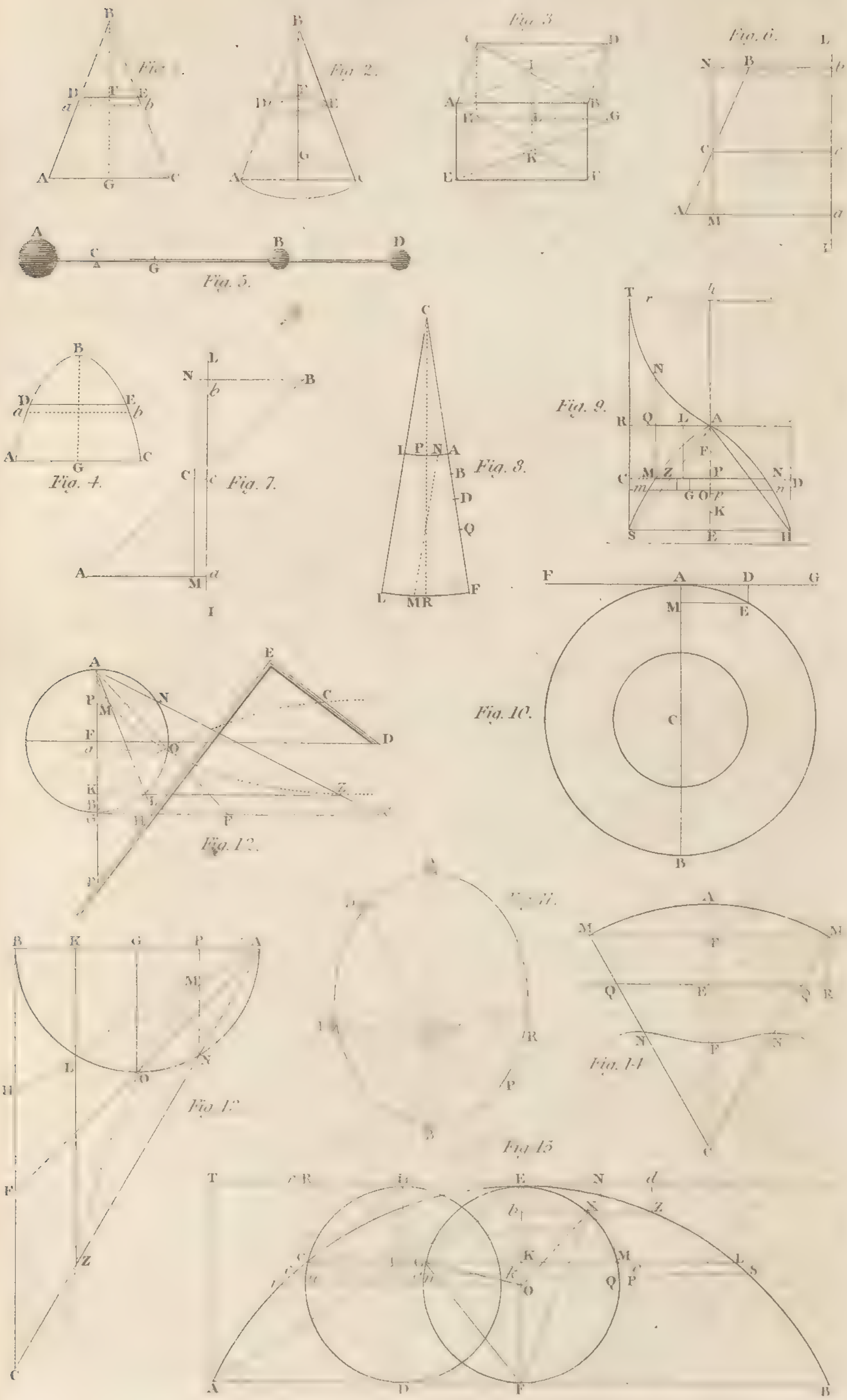
CYCLAS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx four-parted, spreading, with a short turbinate tube; corolla none; filaments inserted into the neck of the calyx; style flexuose; legume roundish, winged, one-seeded. There are two species, *viz.* C. spicata, and C. aromatica, both very tall trees, natives of the great forests of Guiana, flowering in November and December.

CYCLIDIUM, in natural history, a genus of Vermes Infusoria. Worm invisible to the naked eye, very simple, pellucid, flat, orbicular, or oval. There are seven species. C. bulla; orbicular, transparent; in infusions of hay; pellucid, white, with the edges a little darker; motion slow and circular. C. milium; elliptical, transparent; in vegetable infusions; pellucid, crystalline, membranaceous, with a line through the whole length.

CYCLOID, in geometry, a curve of the transcendental kind, called also the trochoid. It is generated in the following manner: if the circle C D H (Plate III. Miscel. fig. 15.) roll on the given straight line A B, so that all the parts of the circumference be applied to it one after another, the point C that touched the line A B in A, by a motion thus compounded of a circular and rectilinear motion, will describe the curve A C E B, called the cycloid, the properties of which are these: 1. If on the axis E F be described the generating circle E G F meeting the ordinate C K in G, the ordinate will be equal to the sum of the arc E G and its right sine G K; that is, C K will be equal to $EG + GK$. 2. The line C H parallel to the chord E G is a tangent to the cycloid in C. 3. The arch of the cycloid E L is double of the chord E M, of the corresponding arc of the generating circle E M F: hence the semi-cycloid E L B is equal to twice the diameter of the generating circle E F; and the whole cycloid

MISCELLANIES.

Plate III.



A C E B is quadruple of the diameter E F. 4. If E R be parallel to the base A B, and C R parallel to the axis of the cycloid E F; the space E C R, bounded by the arc of the cycloid E C, and the lines E R and R C, shall be equal to the circle area E G K: hence it follows, if A T, perpendicular to the base A B, meet E R in T, the space E T A C E will be equal to the semi-circle E G F: and since A F is equal to the semi-circumference E G F, the rectangle E F A T, being the rectangle of the diameter and semi-circumference, will be equal to four times the semi-circle E G F; and therefore the area E C A F E will be equal to three times the area of the generating semi-circle E G F. Again, if you draw the line E A, the area intercepted betwixt the cycloid E C A, and the straight line E A will be equal to the semi-circle E G F; for the area E C A F E is equal to three times E G F, and the triangle $EAF = AF \times \frac{1}{2}EF$, the rectangle of the semi-circle and radius, and consequently equal to 2 E G F; therefore their difference, the area E C A E, is equal to E G F. 5. Take $Eb = OK$, draw bZ parallel to the base, meeting the generating circle in X, and the cycloid in Z; and join C Z, F X; then shall the area C Z E C be equal to the sum of the triangles G F K and bFX. Hence an infinite number of segments of the cycloid may be assigned, that are perfectly quadrable.

For example, if the ordinate C K be supposed to cut the axis in the middle of the radius O E, then K and b coincide; and the area E C K becomes in that case equal to the triangle G K F, and EbZ becomes equal to FbX, and these triangles themselves become equal.

This is the curve on which the doctrine of pendulums and time-measuring instruments in a great measure depend; Mr. Huygens having demonstrated, that from whatever point or height a heavy body oscillating on a fixed centre begins to descend, while it continues to move in a cycloid, the time of its falls or oscillations will be equal to each other. It is likewise demonstrable, that it is the curve of quickest descent, *i. e.* a body falling in it, from any given point above, to another not exactly under it, will come to this point in a less time than in any other curve passing through those two points.

CYCLOPÆDIA, or Encyclopædia, denotes the circle or compass of arts and sciences.

CYCLOPTERUS, the *sucker*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: head obtuse; tongue short and thick; teeth in the jaws; body short, thick, and without scales; ventral fins united into an oval concavity, forming an instrument of adhesion. There are ten species, of which the principal is C. lumpus, the lump-sucker. The shape of this fish is very similar to that of the bream, and it sometimes grows to the weight of seven pounds. Beneath the pectoral fins it possesses an oval aperture, surrounded with a soft muscular substance, edged with small thready appendages, which act as so many claspers. By this apparatus the sucker is enabled to adhere with extreme tenacity to any substance, and in several cases it has been found impossible to make it quit its hold but by the application of a force which has lacerated and destroyed it. M. Pennant mentions, that one of these fishes, soon after being caught, was flung into a pail of water containing several gallons, and attached itself in a few moments so strongly to the bottom of the vessel that, on taking the fish by the tail, the whole vessel was lifted together with its contents, and the fish appeared to shew no disposition to quit its hold. These fishes are eaten commonly in Greenland, where their oily quality renders them particularly pleasing. In England they are thought tasteless and flabby. In Scotland, near Caithness, suckers are found in immense shoals. They are pursued on that coast with the most destructive havock, by the seals which there also abound. During the season in which these ravages are committed, the spot under which they take place is distinguishable by the smooth and oily surface of the water for a considerable extent. The skins of the suckers, which are rejected by the seals, are also found in vast abundance on the shores. For a variety of this species, called C. pavonius, or the Pavonian sucker, see Pisces, Plate III. fig. 3.

CYDER, a well-known liquor, serving in many parts of England as a common beverage, though not considered to be so wholesome as well-made beer, especially to persons troubled with gravel, or chronic complaints of any kind. Cyder is made from apples, which should be mellow ripe, and gathered when perfectly dry. It was formerly held as a general opinion, that "the worse the fruit the better for cyder;" but such an absurd opinion was in time, though slowly, refuted. The best pippins make the best flavoured and the wholesomest

liquor; and such as are duly ripe will produce a proportionate increase, both of the quantity and of the flavour. Some persons are so curious in this particular, that they select their apples individually, and keep the juice barrelled for several years, whence it acquires considerable strength and richness, equal, if not superior, to many of the inferior classes of foreign wines. When boiled, and kept in this way, it is called cyder wine.

It is to be lamented that very large quantities of crude cyder are made in some districts from unripe apples, especially from windfalls. This liquor is peculiarly unwholesome, and rarely fails, if drank to excess, to induce violent colics, and spasms of long duration. The evil is increased by the incautious practice of drawing the expressed liquor into copper or leaden vessels, from which it receives a metallic solution that proves in most instances fatal. Even those who make cyder with the utmost care and cleanliness from unripe apples should be particularly attentive to its due fermentation, without which, though it may not immediately turn sour, it will neither be palatable nor wholesome. Such should be aided while fermenting by the addition of a very large toast, made of good wheaten bread, well leavened; and if that should fail, the cyder should not be used without the addition of about a quart of good spirits to two or three gallons of the liquor. This will prevent the acetous fermentation from taking place, and reduce the bad qualities of this crude beverage.

Exclusive of the state of the fruit when gathered, much depends on the care with which it is taken down, and conveyed to the sweating room: such apples as are bruised should be rejected, or at least be made separately; for they will give a taint to the liquor; and, if numerous, will also occasion the fermentation to be unequal: a matter of great importance! Apples should be gathered by hand, and slipt into a basket by means of such a ladder and cloth funnel as represented in the Agricultural Magazine for September or October, 1807, whereby they are saved from injury.

The proper degree of ripeness is easily ascertained by those who are in the habit of gathering; such persons know by the touch, and by the mellow appearance, of proper fruits when they are fit for the press: the shaking of the kernels is extremely uncertain, as is also the colour of the kernels. When a hard sort of apple bites crisp, and flakes without toughness, it is in proper condition. The softer fleshed apples may be tried by pressing the thumb on that side which has not been exposed to the sun. If the flesh pits easily, and soon assumes a bruised appearance, the juices are sufficiently prepared for expression. By trying the sun-side of the apple much deception is often experienced.

Those who are very curious in their cyder pick off all the stalks, and wipe each with a dry cloth; but this cannot be done upon a large scale. However, all filth should be avoided as much as possible. The fruit when first pulled should be laid to air on a floor, and in a day or two should be piled. If the weather proves frosty, a blanket should be laid at night over each heap, that the whole may be kept in a very gentle sweat. This dissipates much of the aqueous fluid, and disposes the apples to break freely in the mill, without which there would be double labour and far less produce. When they appear clammy, or begin to look shrivelled, they are in a state for milling. The mill and press are made upon different plans in various parts; those who make cyder for sale, and can shew many hundred hogsheads, generally have a horse walk, and grind the apples by means of a trough, wherein they are crushed by a large stone roller, about a foot broad, and three or four feet high, which revolves on an axis fast at one end to a central post, and at the other having a hook to which the horse is attached. The horse goes round at an easy pace, so as not to hurry the apples out of the trough while the stone partakes of the circular motion, and mashes the apples, which are confined by the two concentric sides of the trough. The mills are usually made in a very negligent manner, whereby the apples are very insufficiently and unequally ground; besides it is extremely difficult to keep the troughs clean, and to prevent the apples from jumping out when first acted upon by the stone, unless the walls or sides are inconveniently high, or that only a thin layer is bruised at a time. To remedy this, we offer a new form for the trough and stone, which it will be obvious remedies the former evil. (See fig. 3 and 4, Plate IV. Miscel.)

In the same plate is shewn the mode of keeping the apples from rising before the wheel: it is simply a board which fits flat upon the top of the circular trough. This board is fixed by two arms to the axis on which the stone revolves, and by means of

hinges at their junction will rise and fall according as the stone may sink more or less into the trough; thus causing the board always to keep at its proper distance in front. The board may have one or two iron pins on each side, pointing downwards for two or three inches, for the purpose of guiding and retaining it in the proper direction on the circular surface of the trough.

The best and most commodious grinding mills for ordinary use consists of an oblong funnel, capable of containing about two bushels; this directs the apples down to two cylinders, placed horizontally at about half an inch or less asunder. Each cylinder is furnished with many rows of strong teeth; between each two there is a mortice, so that as one is set in motion by a crank, or winch handle, it locks mutually in with the other, and causes it to revolve with a counter-motion, thereby catching in the apples, and forcing them through between the rollers into a receiver placed below. The cylinders may be about a foot long, and perhaps four or five inches in diameter. Many use iron teeth; but those made of lignum vitæ are preferable. They should be about an inch square, and project nearly as much, their ends being cut to a wedge form. These teeth ought to be in regular bands, with intermediate mortices for the reception of those locking in from the other cylinder; the bands or rows to be about two or three inches asunder, and the teeth about two inches apart. Fig. 5. in the same plate will give some idea of this machine, which will be found also in the Agricultural Magazine for February or March, 1808.

The pulp is put into cloth receivers, made of horse hair; and being piled in as many layers as the machine will contain, is compressed by the means of large levers turning a wooden pillar screw, the same as in the paper manufactories, &c. so that all the juice is forced out, and the pulp is rendered dry and thin. The liquor thus obtained is called stum, and the residuum is called murk. The latter is frequently broken up, and being infused with boiling water, is again pressed for the purpose of giving a small liquor called cyderkin, purre, or perkin. Some add hops thereto, which makes it keep very well. If too much water be not put, say about one-third the quantity of expressed juice, the cyderkin will prove good. It ought to remain 48 hours before re-pressed. The best way is to grind the murk a second time, whereby much more liquor will be obtained. The cyder should be put into very clean, sweet casks, which should not be filled, but a small space left for the working. The duration of the ferment is uncertain, being from a week to a month, or more, according to the state of the atmosphere. If the fruit be in a proper state, and that no frost should intervene, it will generally be regular; but in the latter case artificial warmth, not exceeding 60 degrees, may be used, and a piece of well-toasted bread be put in. When the fermentation is declining, draw off the cyder from its lees, by means of a cock at a few inches from the bottom of the cask, and put it into another vessel, which must, after the first effervescence, be well filled, and be bunged up very close.

It is proper to state in this place, that very large quantities of good stum are annually spoilt by being placed, either in too hot situations, where the fermentation proceeds unduly to the second, or acetous degree; or in too cold and damp a cellar, &c. as where the fermentation is tardy and imperfect. Cyder left to work upon coarse foul lees will ferment with great vigour, but is apt to expend itself, and to leave either an insipid subacid liquor, or to burst the casks if closed too soon. Spirits are the best preventative to both; on the continent, and in America, we understand, that those few who make good cyder (which is extremely scarce in those parts, though apples of the finest quality abound) invariably doctor the stum when the fermentation is either defective or excessive: having abundance of spirits they can easily prevent that mischief which in this country could not be obviated at any moderate expense. When cyder fails, and becomes acid, the acetous change should be encouraged: it makes excellent vinegar, worth at least two shillings and six-pence the gallon; whereas in cyder countries the same quantity used as beverage would not produce more than two shillings; from which deduct the duty, which is about five-pence per gallon. When cyder has been well made, and is put into capacious vessels, it will keep sound for many years; becoming rich and mellow: in small quantities it is more apt to become flat. When bottled for many years it is common to find it taste very strongly of the cork; and if the straw in which it is packed be not thoroughly dry, the liquor will acquire a very unpleasant musty flavour. All preparations used for fining cyder are highly injurious to its quality: racking from the lees, into fresh vessels, after the fermen-

tation has moderated, is the only proper mode of removing the impurities.

We are concerned to state, that those kinds of apples which were so long famous for yielding a fine stum, are much on the decline; and that no means have hitherto been discovered of preventing the untimely decay of the trees. It is to be hoped, that we shall either receive some fresh grafts from the continent, or that some ingenious person will devise the means of preserving what we have from the canker; which destroys our best orchards after a few years of growth.

Explanations of Plate IV. Miscel. fig. 3. A shews the vertical section of the stone roller, with its axis C, C. The suggested improvement consists in rounding its edges, and in suiting the bottom of the trough B, B, B to that shape.

Fig. 4, shews the side of the wheel, half-way buried in the trough, of which L is the upper line, and K K the bottom. The arm E moves freely on the axis F, and is fastened at C, by a hinge, to the board H H; which is kept in its place, on the surface of the trough, by the pins I I; of which there are two on each side. Thus as the wheel (or stone) D, revolves, at whatever height the board will maintain its position. If too light, it may be loaded.

Fig. 5, shews the two cylinders, with their manner of locking into each other; one crank turning both; the teeth *o, o,* fitting into the mortices *p, p.* The wheels M and N, having by this means, contrary motions, catch the apples between their approaching surfaces, and by aid of the teeth crush them into small pieces; which are reduced to a perfect pulp as they pass between the rollers, into the vessel below. X is the handle of the winch.

This machine, fig. 5, is in common use in the west of England, and is found to answer well.

CYGNUS, in astronomy, a constellation of the northern hemisphere. See ASTRONOMY.

CYLINDER, in geometry, a solid body, supposed to be generated by the rotation of a parallelogram. If the generating parallelogram be rectangular, the cylinder it produces will be a right cylinder, that is, it will have its axis perpendicular to its base. If the parallelogram be a rhombus, or rhomboides, the cylinder will be oblique or scalenous.

CYLINDER, *properties of the.* 1. The section of every cylinder by a plane oblique to its base, is an ellipsis. 2. The superfices of a right cylinder is equal to the periphery of the base multiplied into the length of its side. 3. The solidity of a cylinder is equal to the area of its base, multiplied into its altitude. 4. Cylinders of the same base, and standing between the same parallels are equal. 5. Every cylinder is to a spheriod inscribed in it, as 3 to 2. 6. If the altitudes of two right cylinders be equal to the diameters of their bases, those cylinders are to one another as the cubes of the diameters of their bases.

To find a circle equal to the surface of a cylinder, we have this theorem: the surface of a cylinder is equal to a circle, whose radius is a mean proportional between the diameter and height of the cylinder. The diameter of a sphere, and altitude of a cylinder equal thereto, being given, to find the diameter of the cylinder, the theorem is, the square of the diameter of the sphere is to the square of the diameter of the cylinder equal to it, nearly, as triple the altitude of the cylinder to double the diameter of the sphere.

CYLISTA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx very large, four-parted; the upper division cleft at the end; corolla permanent. There is but one species, *viz.* C. villosa, hairy cylista. It flowers in April and May; was introduced in 1776, but from what country is not known. It is a shrub, and requires the heat of the stove to preserve it.

CYMBACHNE, in botany, a genns of the Polygamia Monoecia class and order. Natural order of Gramina, or grasses. Essential character: inflorescence half spiked; herm. calyx two-glumed, one-flowered, parallel to the rachis; outer valve linear, the opposite boat-form; female calyx one-glumed, ovate, opposite to the rachis. One species, *viz.* C. ciliata. This is a slender grass, a foot in height, with several culms, simple or branched, with a single leaf, or leafless. It is found in Bengal.

CYMBAL, a musical instrument in use among the ancients. The cymbal was round, made of brass, like our kettle-drums, and, as some think, in their form, but smaller, and of different use.

CYMBARIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx ten-toothed; capsule cordate, two-celled.

There is only one species, *viz.* C. daurica, a native of the mountains of Dauria.

CYNANCHUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; nectary cylindric, five-toothed. There are twenty-seven species. These shrubs are commonly twining; leaves opposite; flowers axillary or terminating, disposed in spikes, corymbs, or umbels. These are plants chiefly inhabitants of hot climates. They are tender, and will not thrive in this country, unless they are placed in a bark stove.

CYNARA, the *artichoke*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx dilated, imbricate, with fleshy scales, emarginate with an acumen. There are six species. The artichoke in its wild state is said to attain the height of a man. The leaves are more tomentose than in the garden plant, and every small division of them is armed with a strong yellowish spine. The heads are smaller, and have larger stronger spines at the ends of the scales. It is a native of the south of Europe. In some parts it is eaten raw in its wild state by the common people. It will dye a good yellow: the flowers are used instead of rennet to turn milk for cheese. The whole plant has a peculiar smell, and a strong bitter taste.

CYNICS, a sect of ancient philosophers, who valued themselves upon their contempt of riches and state, arts and sciences, and every thing, in short, except virtue or morality.

The sect of the Cynics, founded by Antisthenes, is not so much to be regarded as a school of philosophy, as an institution of manners. It was formed, rather for the purpose of providing a remedy for the moral disorders of luxury, ambition, and avarice, than with a view to establish any new theory of speculative opinions. The disciples of Antisthenes and other leaders of this sect, considered their masters, not as authors of any new doctrine, but as patrons of strict and inflexible virtue; and were regarded by them, rather as examples for their imitation in the conduct of life, than as preceptors to guide them in the search of truth.

The sole end of the Cynic philosophy was, to subdue the passions, and produce simplicity of manners. The characteristic peculiarities of the sect were, an indignant contempt of effeminate vices, and a rigorous adherence to the rules of moral discipline. A Cynic, according to the original spirit of the sect, was one who appeared in a coarse garb, and carried a wallet and staff, as external symbols of severity, and who regarded every thing with indifference, except that kind of virtue which consists in a haughty contempt of external good, and a hardy endurance of external ill. Simplicity and moderation were indeed in this sect carried to the extreme of austerity, and at last produced the Stoic system of apathy; but the real design of the founders both of the Cynic and the Stoic sect, seems to have been to establish virtuous manners. The rigorous discipline which was practised by the first Cynics, and which afterwards degenerated into the most absurd severity, was at first adopted for the laudable purpose of exhibiting an example of moderation and virtuous self-command. If, in executing this praise-worthy design, a portion of vanity blended itself with the love of virtue, who will not be inclined to pardon the weakness, out of respect to the merit of the character? That they might be perfectly at liberty to apply themselves to the cultivation of virtuous habits and manners, without interruption from the noisy contests of speculative philosophy, the Cynics renounced every kind of scientific pursuit; contending, that to those who are endued by nature with a mind disposed to virtue, the pursuits of learning are an unnecessary and troublesome interruption of the main business of life. Hence they entirely discarded all dialectic, physical, and mathematical speculations, and confined themselves to the study, or rather to the practice of virtue. This was certainly injudicious; but it is some apology for their error, that Socrates had taken pains to inspire his followers with a contempt of theoretical science, when considered in comparison with practical wisdom. It may also be added, that the learning which flourished at that time in Greece, chiefly consisted in futile speculations, and an illegitimate kind of eloquence, which contributed little towards the happiness of society, or the real improvement of the human mind.

The sum of the moral doctrine of Antisthenes and the Cynic sect is this: Virtue alone is a sufficient foundation for a happy life. Virtue consists, not in a vain ostentation of learning, or an idle display of words, but in a steady course of right conduct. Wisdom

and virtue are the same. A wise man will always be contented with his condition, and will live rather according to the precepts of virtue, than according to the laws or customs of his country. Wisdom is a secure and impregnable fortress; virtue, armour which cannot be taken away. Whatever is honourable is good; whatever is disgraceful is evil. Virtue is the only bond of friendship. It is better to associate with a few good men against a vicious multitude, than to join the vicious, however numerous, against the good. The love of pleasure is a temporary madness. The following maxims and apothegms are also ascribed to Antisthenes: As rust consumes iron, so doth envy consume the heart of man. That state is hastening to ruin, in which no difference is made between good and bad men. The harmony of brethren is a stronger defence than a wall of brass. A wise man converses with the wicked, as a physician with the sick, not to catch the disease, but to cure it. A philosopher gains at least one thing from his manner of life, a power of conversing with himself. The most necessary part of learning is, to unlearn our errors. The man who is afraid of another, whatever he may think of himself, is a slave. Antisthenes, being told that a bad man had been praising him, said, "What foolish thing have I been doing?"

CYNIPS, *gall-fly*, in natural history, a genus of insects of the order Hymenoptera. Generic character: mouth with a short one-toothed membranaceous jaw, the mandibles vaulted; horny cleft, the lip entire, feelers four, short unequal capitate; antennæ moniliform; sting spiral, often concealed within the body. There are 35 species enumerated. The numerous excrescences, or galls, found on the roots, branches, and leaves of various trees are produced by the puncture of these insects: the larva is without feet, soft, cylindrical, and inhabits within the gall, feeding on the juices of the tree: the pupa resembles the perfect insect, except in having only the rudiments of wings. C. querci, or oak-leaf cynips, is of a burnished shining brown colour. It is found in the hard galls under oak-leaves, generally fastened to the fibres. Frequently instead of the cynips there is seen an ichneumon, which is a larger insect. This is not the inmate of the gall, or he that formed it, but a parasite, whose mother deposited her eggs in the yet tender gall, which, when hatched, brings forth a larva that destroys the larva of the cynips, and comes out when it has undergone its metamorphosis, and acquired its wings. The cynips of the oak-bud is of a very dark green, slightly gilded: it produces one of the finest galls, leafed like a rose-bud beginning to blow. The gall is often an inch in diameter.

CYNOGLOSSUM, in botany, English hound's-tongue, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla funnel form, the throat closed with arches; seeds flat, affixed to the style by the inside only. There are twelve species.

CYNOMETRA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Leguminosæ. Essential character: calyx four-leaved; anthers bifid at the tip; legume fleshy, crescent shaped; one-seeded. There are two species, *viz.* C. cauliflora and C. ramiflora. These trees are natives of the East Indies. Their flowers are conjugate; and their peduncles are many flowered.

CYNOMORIUM, in botany, a genus of the Monoecia Monandria class and order. Natural order of Amentaceæ. Essential character: male calyx an imbricate ament; corolla none; female calyx in the same ament; corolla none; style one, seed one, roundish. There are three species.

CYNOSURUS, in botany, dog's-tail, a genus of the Triandria Digynia class and order. Natural order of Gramina or Grasses. Essential character: calyx two-valved, many-flowered; receptacle proper, unilateral, leafy. There are twenty species. Several of them are natives of the East and West Indies. Few of these are known in Europe, otherwise than by specimens or description.

CYPERUS, in botany, a genus of the Triandria Monogynia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: glumes chaffy, imbricate in two rows; corolla none; seed one, naked. There are fifty-three species. Most of these plants have three cornered culms or stems. The flowers in aggregate peduncled and umbelled spikes. The lower chaffs are frequently empty. The greater part of them are natives of the East or West Indies, and will therefore, if propagated here, require the protection of the bark-stove.

CYPHER, or CIPHER. To write in cypher denotes the art of communicating

by writing in such a manner as shall be legible only to those who are acquainted with the rules by which the characters made use of are formed or disposed. It is principally used in diplomatic correspondence, or on other national affairs, such as those relating to the operations of war. As the nature of alphabetic writing, and the structure of languages necessarily imply certain indispensable habitudes of the letters and words, it often happens that the laws or conditions made use of for the sake of secrecy can be detected by skilful persons, and the secret by that means discovered. The art of discovering the sense of writings of the description here mentioned, is called decyphering.

One of the most obvious methods of disguising the alphabet will consist in changing the characters. Thus, for example, if the English language were written in Greek characters, it would not be legible by a person unacquainted with them; or if the English alphabet were to be transposed, as by taking every consequent letter for its antecedant, namely, *b* for *a*, *c* for *b*, *d* for *c*, &c.; or by any other rule of arrangement the same consequence would follow, and the writing would be secret, unless the sagacity of the reader should enable him to develope the conditions; which in the cases here mentioned it would not be difficult to do.

From the comparative facility of decyphering writings, made in a disguised single alphabet, it became necessary to use contrivances of less simplicity. By substituting figures in the place of letters, and by using more than one figure to denote each letter; and, in addition to this, by adopting a considerable number of distinct characters, letters, or combinations of figures, for each letter of the alphabet, the difficulty of decyphering may be prodigiously augmented. Thus, for example, if a table were made consisting of twenty-four vertical columns, having a letter of the alphabet at the head of each; and six distinct ranges of characters were placed on horizontal lines beneath; and, in particular, if a greater number of characters were allowed for the vowels, in proportion to their frequency of recurrence; and, if in writing, each range be used in succession, the developement of a communication thus made would be extremely difficult. Or, otherwise, if a square of twenty-five compartments be made resembling the multiplication table, but containing the letters of the alphabet; and the first five digits be placed over the top row and down the side, each letter may be denoted by the two figures which stand opposite the same, namely, at the top and the side, as in the table beneath.

1	2	3	4	5	
a	*f*	*k*	*p*	*v*	1
b	*g*	*l*	*r*	*w*	2
c	*h*	*m*	*s*	*x*	3
d	*i*	*n*	*t*	*y*	4
e	*j*	*o*	*u*	*z*	5

In this manner, the letter *a* will be denoted by 11, and the letter *b* by 12, the letter *n* by 34, and the letter *w* by 52, &c.; and as it is advantageous, in every kind of cypher, that the words should not be written from each other, or with spaces between, but that every line should be continuous throughout, the other digits, namely, 67890 may be used to denote blank spaces. It is manifest also that if there were four or five of these tables; each containing the alphabet in a different order of arrangement, and the several lines of the intended communication were to be written, in succession, according to each of the tables respectively, the task of decyphering would be greatly enhanced.

In fact, it does not appear difficult to contrive a multiplicity of cyphers which shall be beyond the reach of human skill to develope, otherwise than by some fortuitous circumstance or happy observation, not dependent upon rule; but at the same time it must be observed that most of those cyphers which are the most difficult of discovery are also tedious, and not unfrequently difficult in the use.

For the sake of brevity we pass over the variety of arbitrary marks, which may be substituted for the letters of the alphabet or for intire words; such as a single dot or right line, or unvaried character, deriving its distinct significance from its several positions with regard to ruled lines or spaces on the paper; which lines may either be actually drawn or apparent, or else their places may be indicated by dots or other marks to enable the reader himself to draw them. Writing, by means of the characters of music, comes under this class; and the telegraphic signals now so generally adopted may be referred to those arbitrary combinations of dots which signify letters or words. And when the notion of these combinations has once been clearly appre-

hended, it will be easy to deduce the methods of communicating intelligence by combinations, either contemporaneous or successive, of torches, fires, rockets, or the sounds of bells, trumpets, cannon, and other suitable instruments.

The number of contrivances which have been, or may be adopted for the conveyance of secret intelligence seem capable of unlimited variation, according to the acuteness of the contrivers. Pantomimic signs and gestures are practised by every one, and are usually carried to such an extent, that we forget that the performers in this description of comedy have no oral communication. The expedients of a knotted string, which, when stretched out, shall apply to letters or words upon a guage possessed by the receiver: the scytale of Lysander, or slip of parchment, containing writing which became legible when wrapped round a staff: the elaborate invention of Hystiæus, who pretended to cure a servant of sore eyes by shaving his head, and writing his secret upon the scalp with a scarifying instrument, after which, the man being confined till his hair had grown, this extraordinary epistle became in a fit state to be forwarded along with its bearer to the place of destination. These, and many others of sufficient note in history, as well as the events of common life among smugglers and others, manifest a variety of instances of the secret conveyance of small parcels, such as parchment, paper, cambric, lace, and the like. A pye, or a bottle of wine or beer, small casks of pickles or provision; the interior of the construction of saddles, of shoes, or other parts of wearing apparel; a false skin laced upon a dog; the intestines of a living animal or of the human subject employed in swallowing a small receptacle, containing a letter, to be afterwards evacuated.—This short list of vehicles may point out how extensive the general means of secret communication may be made.

We shall conclude the present article, which would require a volume to do it justice, by mentioning two other modes of communication with a considerable degree of secresy, though they are perhaps liable to the objection of slowness in the writing. The first consists in the use of a dictionary, or other work, which must be paged throughout, and, if convenient, the lines should be counted: but this last necessity may be supplied by means of a scale, or slip of parchment, with lines and numbers from top to bottom, which may be applied to any page when wanted for readily counting the lines. The correspondents being each provided with the same edition of the same work, the writer is to complete his letter in the usual manner; but instead of sending off that copy, he sends another, wherein, instead of the words, he writes for each the page, line, and numerical situation in the line, of each word. The correspondent will therefore discover them by seeking in his dictionary, or printed work. It will easily be seen that this method amounts to the same thing, as if an index locupletissimus were made of the author to the minuteness here mentioned, and one of the numeral indications were to be put down in each instance instead of the word itself. The other method consists in the use of a piece of parchment, ruled with lines corresponding with other lines upon the paper upon which the letter is to be written. Holes are cut through the parchment here and there upon the lines. The parchment thus prepared being laid upon the paper, the letter is to be written through the holes; after which the paper is to be uncovered, and the remaining spaces between the words filled with other matter, so as to make a significant letter. The true letter can therefore only be read by a correspondent in possession of a parchment exactly like the original.

Upon this contrivance it may be remarked, that it is crude and inartificial; and that it supposes the writer to possess sufficient ingenuity and talent to make a rational and clear letter by filling the spaces, and also that he has so much command and management of his pen, as that the secret words shall not be discovered by some crookedness in the line, crowding of the space, difference in the pen or ink, or some other circumstance attendant on the writing. In the event of these or any other failure, the letter will be liable to suspicion. It is true, nevertheless, that the method of writing by interposed words may be rendered less objectionable by placing the significant parts at certain intervals among the others; not by measure, but by reckoning from the beginning, according to some agreed rule; and in this method the objections with regard to penmanship will be done away by writing the letter over again, after it has been once completed.

The method of secret writing by transparent or invisible inks, has been little used in real business, and is entitled to no con-

fidence. This process is effected by using a transparent or dilute solution of some ingredient which becomes coloured by the action of heat or light, or of some other ingredient. Thus, if a letter be written with a dilute solution of sulphate of iron, or green copperas, it will be invisible when dry; but if the paper be wetted by a feather dipped in the infusion of galls, the writing will become black, or if the prussiate of potash be used instead of the galls, the letters will be blue. The objection to sympathetic inks is, that the writing becomes visible spontaneously after a short time, and that most of them are rendered visible by the application of any metallic solution, or simply by holding them to the fire till the paper is a little scorched. When a secret ink is used, it is advisable, in order to prevent suspicion, that a common letter should be written with the ordinary ink between the lines. See INK, and also DECYPHERING.

CYPRÆA, *cowry*, in natural history, a genus of the Vermes Testacea. Animal a slug; shell univalve, involute, sub-ovate, smooth, obtuse at each end, linear, extending the whole length of the shell, and toothed on each side. This is a very numerous genus, of which there are several distinct families, one of these is distinguished by being obtuse, and without any manifest spire; such as the caput serpentinus and tigris, the last of which is well known by the appellation tiger cowry. Another kind is perforated or furnished with an umbellicus, as in the C. ziczac. A different sort is margined like the common West Indian cowry, commonly called "blackamoor's teeth." In the young, the cypræa have much the appearance of a volute, and are entirely destitute of the thick denticulated lip or margin, so obvious in the adult shells.

CYPRESS, the English name of a genus of trees. See CUPRESSUS.

CYPRINUS, the *carp*, in natural history, a genus of fishes of the order Abdominales. Generic character: mouth small and without teeth; gill membrane, with three rays; ventral fins often, and, perhaps, generally nine-rayed. Of this fish there are fifty species, of which it will be sufficient to notice the following: C. carpio, or the common carp. This fish inhabits the slow and stagnant waters of many countries of Europe, in which it is found extremely to vary in size, from 16 inches to the length of 3 or 4 feet. In Persia the carp is not unfrequently found of this length, and will weigh from 30 to 40 pounds. It was introduced into England in the 16th century. It feeds on herbs, worms, and water insects: it is extremely prolific; the roe having been occasionally found to weigh as much as the real substance of the fish: the principle of vitality in the carp is uncommonly strong: it may be kept alive in a damp situation for a very considerable time after being taken from the water; and if wrapped in wet moss, and plunged in water every four hours, and fed on bread and milk, will not only continue to exist but will thrive and fatten: it has been ascertained to live to a very considerable age, when they become completely white. The carp was classed by the ancients among sea-fish; it is, however, generally found in ponds and rivers; and now considered as a fresh-water-fish. For a variety of this species, called the large-scaled carp, see Pisces, Plate III. fig. 4.

C. auratus, or gold-fish. This was introduced into England at the close of the 17th century; and, towards the middle of the last, was become extremely common. It exceeds in splendour all the other inhabitants of the waters; in the full grown fish the prevailing colour is that of the richest gold, accompanied by a tinge of scarlet on the upper part, and of silver on the lower. Its native spot is supposed to be the province of Kiang in the south of China, from which it has been conveyed to every part of that vast empire, being introduced into the gardens of the opulent, and even into their apartments, in vases of immense size, and the most exquisite workmanship. It appears sensible to favours, and capable of attachment; and by the sprightliness of its movements, also as well as the unrivalled splendour of its colours, is one of the most interesting objects of care and attention to the ladies of that country. In England it has now long excited particular regard. It is fed with small worms and fine bread, and occasionally with the yolks of eggs dried and pounded to powder; it breeds as rapidly as the common carp; a frequent change of water is desirable for it, particularly in hot weather, and the vessel in which it is kept should be considerably open to the air.

C. tinca, or the tench. This is found in almost every country, and is sometimes seen of the weight of eight, ten, and even twenty pounds: its common length, however, is about twelve inches; and its scales, as numbered by some curious naturalists, to have amounted to thirty thousand; its favourite

haunts are stagnant waters, which have a soft and muddy bottom, and under this it is supposed, by many, to lie concealed and torpid during the winter. The ancients considered it as a fish fit only for vulgar tables, and in Germany the same opinion is now prevalent; in England, however, it is considered as a delicacy. It differs much in quality according to the situation it dwells in, and the male fish is generally considered as far superior to the female. The tench resembles the carp in extraordinary tenaciousness of life, as also in rapid growth and extreme fecundity.

C. jeses, the chub, is a fish frequently to be met with in this country, but is generally much smaller here than in many other parts of Europe, as it weighs in Germany commonly from five to eight pounds: it is strong and swift, and prefers the most clear and rapid streams; it grows but slowly, and it is considered as tasteless and coarse food.

C. gobio, or gudgeon, abounds much in the rivers of this country, particularly in the Kennet and Cole, where it is also in the highest perfection. Gudgeons very rarely exceed a few ounces in weight: they prefer small lakes and gently flowing rivers, especially where there is a gravelly bottom, to all other situations; small worms and aquatic insects are their food, and in quest of these they almost always remain at the bottom of the streams where they reside: they are extremely prolific, and highly admired for the table: they do not deposit at once all their spawn, but with considerable intervals, so that the whole process continues for a month. In some places of Germany the lakes are most copiously stored with these fish.

C. phoxinus, or minnow, is frequent in clear gravelly streams, and in England appears first in March, and towards November shelters itself in the muddy or gravelly bottom, remaining in this secreted and, perhaps, in a torpid state, during the winter: it is about three inches in length; and is one of the most elegant of European fishes: it is gregarious, and though but seldom used for food on account of its minute size, is regarded as a very delicate fish: it is frequently employed as bait for trout and other comparatively large fishes known to prey upon them with great avidity.

CYPRIPEDIUM, in botany, English ladies' slipper, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary ventricose, inflated, hollow. There are five species.

CYRILLA, in botany, so named in honour of Dominico Cyrillo, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Essential character: calyx superior, five-leaved; linear lanceolate; corolla declined, funnel form; tube cylindric, gibbous on its lower edge; throat tricallous; segments roundish, the three lower more produced; filaments inserted into the margin of the corolla, incurved, with a fifth barren; anthers cohering; germ inferior, half emerging, with a nectareous lid; style bent down; stigma two-lobed; capsule half two-celled, with two parted receptacles; seeds numerous. There is but one species, *viz.* C. pulchella, a native of Jamaica.

CYRTANTHUS, in botany, a genus of the Hexandria Monogynia class and order: Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: corolla tubular, club-shaped, crooked, six-cleft; segments ovate oblong; filaments inserted into the tube, converging at top. There are two species, *viz.* C. angustifolius, narrow-leaved cyrtanthus, and C. obliquus, oblique-leaved cyrtanthus. These are both natives of the Cape of Good Hope.

CYTINUS, in botany, a genus of the Gynandria Octandria class and order. Natural order of Aristolochiæ, Jussieu. Essential character: style one; calyx four-cleft, superior; corolla none; anthers sixteen, sessile; berry eight-celled, with many seeds. There is but one species, *viz.* C. hypocistis, rape of cistus, a parasitical plant growing at the roots of the cistus; leaves sessile, closely imbricate; flowers terminating, heaped. Native of the country of Nice, Spain, Portugal, and Barbary.

CYTISUS, in botany, laburnum, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-lipped; upper lip two-cleft; lower three-toothed; legume attenuated at the base. There are eighteen species. All the cytisus's are shrubs without spines, most of them fit for ornamental plantations. They are hardy; the leaves are ternate, and in some the flowers grow in bunches.

D.

D. One of the letters of the alphabet, the fourth in order, and the third consonant. It is formed in the voice, by applying the top of the tongue to the forepart of the palate, and then separating them with a gentle gust of the breath, the lips being at the same time open.

As a numeral D denotes 500; and with a dash over it, thus $\bar{D}$, 5000. Used in abbreviation, it has various significations: thus, D. stands for doctor, as M. D. doctor of medicine; D. T. doctor of theology; D. D. signifies doctor of divinity; D. D. D. is used for dat, dicat, dedicat; and D. D. D. D. for dignum deo donum dedit.

DAB. See PLEURONECTES.

DACE, a species of Cyprinus.

DACTYL, in ancient poetry, a metrical foot, consisting of one long and two short syllables, as mūrmŭrĕ. The dactyl and spondee are the only feet or measures used in hexameter verses; the former being esteemed more sprightly, and the latter more solemn and grave.

DACTYLIOMANCY, a sort of divination, performed by means of a ring; consisting chiefly in holding the ring suspended by a fine thread over a round table, on the edge whereof were made several marks with the twenty-four letters of the alphabet; and as the ring, in shaking or vibrating over the table, happened to stop over certain of the letters, these being joined together composed the answer required.

DACTYLIS, in botany, a genus of the Triandria Digynia class and order. Natural order of Grasses. Essential character: calyx two-valved, compressed; one valve larger, keeled. There are seven species, of which D. cynosuroides, American cock's-foot grass is a perennial, and a native of Virginia and Canada. The culms are two feet high and reedy; leaves on the culm six, broad, very glossy, scabrous about the edge, bent in; spikes six or more, diverging, chaffy; calyxes one flowered, scabrous on the keel, mucronate; pistils villose, very long.

DÆMON, a name given by the ancients to certain spirits, or genii, which, they say, appeared to men, either to do them service or to injure them. The Platonists distinguish between gods, dæmons, and heroes. The gods are those whom Cicero calls *Dii majorum gentium.* The dæmons are those whom we call angels. Christians by the word dæmon, understand generally evil spirits; but the late learned Mr. Hugh Farmer has investigated the subject with the utmost care, and shews upon seemingly incontestible evidence that the word is applied always to human spirits. From the arguments adduced by the same author, it should appear, that all persons spoken of as possessed with devils in the New Testament, were either deranged or epileptic, and in the same condition with madmen and epileptics of modern days.

DAFFODIL, the same with the narcissus of botanists.

DAGYSA, in natural history, a genus of the Vermes Mollusca. Generic character: body loose, nayant, angular, tubular, and open at each extremity. One species, *viz.* D. notata, found in the Spanish sea, is about three inches long and one thick. Body marked at one end with a brown spot. This genus is very like the SALPA, which see.

DAIRY. See AGRICULTURE.

DAIS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Vepreculæ. Thymelææ, Jussieu. Essential character: involucre four-leaved; corolla four or five-cleft; berry one-seeded. There are three species, of which D. cotinifolia, cotinus-leaved dais, is an ornamental green-house shrub, of the deciduous kind, not having yet produced any perfect seeds here, as it does in Holland, it keeps up a very high price among nursery-men.

DAISY. See BELLIS.

DALBERGIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: filaments two, four-cleft at top. Fruit pedicelled, not opening, leguminose, membranaceous, compressed. There are two species, *viz.* D. lanceolaria and D. monetaria; the former is a native of Malabar and Ceylon, the latter of Surinam, in moist places.

DALECHAMPIA, in botany, so called

in honour of Jacobus Dalechampius, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoecæ. Euphorbiæ, Jussieu. Essential character: outer common involucre with four leaflets; inner with two trifid leaves; male, umbellule ten-flowered; involucre two-leaved, with numerous chaffs; proper perianth five-leaved; corolla none; filaments very many, connate; female floscules three; involucel three-leaved; proper perianth with eleven leaflets; corolla none; style filiform; capsule tricoccous. There are two species, *viz.* D. colorata, coloured dalechampia, found in New Granada; and D. scandens, climbing dalechampia, is a native of the West Indies.

DAMA. See CERVUS.

DAMASKEENING, or DAMASKING, the art or operation of beautifying iron, steel, &c. by making incisions therein, and filling them up with gold and silver wire; chiefly used for adorning sword blades, guards, and gripes, locks of pistols, &c.

DAMASONIUM, in botany, a genus of the Hexandria Hexagynia class and order. Essential character: spathe one-leafed, perianth one-leafed, three-parted; petals three; berry ten-celled, inferior. There is but one species, *viz.* D. alismoides, with heart-shaped leaves, nerved, floating, unarmed; scape naked, quadrangular, one-flowered. There are only six stamens in the flower, with six bifid styles. Native of the East Indies, Malabar, Ceylon, &c.

DAMPS, in natural history, noxious steams and exhalations, frequently found in mines, pits, wells, and other subterraneous places. See GAS.

DANCE, or DANCING. The causes which produce the active operation of dancing, are as completely inherent in the human system, as any of those which are generally called involuntary affections of the nerves. A review of the history of mankind will serve to prove that the passions are expressed by the same disposition of the muscles in every quarter of the globe, and that joy has produced an inclination to dance throughout the individuals of nations, who know not of each others existence. In the very early ages of the world, before civilization had polished the ideas, sudden joy may be supposed to have been almost the only stimulus to dancing, and this supposition is corroborated by present observation; the moderns have, indeed, so far refined their feelings, that their disposition to leap or skip with joy is confined to the minuet step in walking, which may be frequently discovered when the features express pleasure. On the contrary, the rude child of nature endued with nerves of exquisite sensibility, having obtained some desired object, received that inexplicable shock, which the Divinity hath decreed man shall not fully comprehend; immediately the subtle pleasure extended to every fibre of his frame, and the convulsive motion became a dance; as joy is communicable, his family were inspired, his neighbours caught the infection, and the manner of this first dance necessarily assumed some degree of method to prevent collision. Such may have been the principal cause of dancing, another arises from certain combinations of sounds, which vibrating strongly upon the air, communicates an impulse to the delicately sensible something residing in the nervous system when the sounds are musical, the limbs are compelled to answer to them, and whether they are merely sufficient to produce a march, or measured steps, or powerful enough to excite violent action, they equally belong to dancing. In order to demonstrate the truth of the above remarks, it may be necessary to mention the present state of dancing in savage life; the natives of Africa, particularly, carry it to the most extravagant excess, a few strings stretched across a dried calabash struck by the fingers, producing a set of deep discordant tones, is a sufficient stimulus for the inhabitants of a village to weary nature completely, and this passion never leaves even the unhappy slaves conveyed thence to the West Indies and America, who dance away those hours granted them for repose. The Indians of North America, more ferocious in their manners, have their war dances, and others suited to the dreadful operation of torturing their prisoners. The natives of the places discovered by Captain Cook, entertained him with well contrived movements by their experienced dancers, and he witnessed others locally festive and funereal; and the Mexicans dance in a barbarous style to the sounds of drums and pipes, similar to those of Otaheite.

Having thus shewn that dancing is less an art, than a natural effect of joy and lively musical sounds, it will be necessary to trace its history when polished and improved by art, some indeed consider it as a branch of the fine arts, and closely allied to dramatic poetry. Dancing was used by the refined nations of antiquity as a

religious tribute; the apostate Israelites danced round their golden calf; and at the more improved period, when King David composed his inspired lines, the Supreme Being received public homage in solemn movements, and that monarch, affected by the most lively joy at the return of the sacred ark from captivity, danced before it with the greatest fervour in the grand procession which restored it to the lawful proprietors.

Plato classes the dances of antiquity under three heads: the gymnopedique, performed by naked children, which were preparatory to the enoplian, or pyrrhic, danced by young men armed, in which they were taught the movements necessary for attack or defence; the Spartans decreed by law, that all male youths who had attained their fifth year, should be trained to these military dances. The second class mentioned by Plato, was solely for amusement; amongst the variety under this head, they had some extremely simple, particularly the ascoliasmus, performed by jumping with one foot on oiled and distended bladders to the sound of voices, and the kybeslesis, now known in England as the somerset; but those, and others of their dances degenerated into voluptuousness and indecency. The third class, or the religious, were considered indispensable in the celebration of all their mysteries; the most ancient was the bacchic, the most solemn the hyporchematic, suited to the accompaniments of a lyre and the voice. Plutarch mentions a dance composed by Theseus, and performed by him and a number of youths round the altar of Apollo on his return from Crete, which consisted of the strophe, the antistrophe, and the stationary, in the first, the movements were from the right to the left; in the second, the reverse; and in the last, the performers danced a slow movement before the altar.

The Greeks made dancing an appendage to their dramatic representations, and were imitated, and even excelled by the Romans, particularly in the Augustan age, when Pylades danced and used such action and gesticulation as expressed all the pathetic emotions of tragedy, and Bathylus, his contemporary, was equally happy in exhibiting the more lively passions. In short, such were their excellence in ballet or pantomimic dancing, that as they had brought the art to its acme, so it declined with them, nor was it revived till the celebration of the marriage of Galias, Duke of Milan, with Isabella of Arragon, in the 15th century, when a Lombard nobleman exhibited a ballet at Tortona of the most splendid description, that excited the warmest approbation throughout Europe, and served as a model for imitation. Since the above period, almost every civilized nation has adopted stage dancing, which is now arrived to great perfection in England, nor has private dancing experienced less attention, as many treatises have been written on the subject, amongst which is "Weaver's Essay towards an History of Dancing;" and Tomlinson, a celebrated dancing master in the reign of Queen Anne, published an entertaining work, in which he terms dancing a science, and described the steps by printed characters; to those may be added, Noverre's, Gallini's, and Peacock's observations and instructions; the latter gentleman declares "The fondness the Highlanders have for this quartett, or trio, (the Scotch reel) is unbounded; and so is their ambition to excel in it. This pleasing propensity, one would think, was born with them, from the early indications we sometimes see their children shew for this exercise. I have seen children of theirs, at five or six years of age, attempt, nay even execute, some of their steps so well, as almost to surpass belief. I once had the pleasure of seeing, in a remote part of the country, a reel danced by a herd boy and two young girls, who surprized me much, especially the boy, who appeared to be about twelve years of age. He had a variety of well chosen steps, and executed them with so much justness and ease, as if he meant to set criticism at defiance. Circumstances like these plainly evince, that those qualities must either be inherent in the Highlanders, or that they must have an uncommon aptitude for imitation." The music and dancing of Scotland is greatly admired in England, in truth, there is something so exhilirating and lively in the sounds of the former, that the writer of this article has frequently observed, the heads and feet of a large audience suddenly set in motion by the unexpected performance of one of their favourite airs. Sensible of this predilection, it is not uncommon for the London professors of dancing to visit Edinburgh, in order to obtain a thorough knowledge of the steps and inflections used in the reels, and other dances peculiar to Scotland. Many modern votaries of this art have acquired the greatest precision in the movements and figures, to

which they have added so much animation and dignity in their performance, that instances have occurred of personages of high rank, who, in the simple minuet, displayed such noble grace, as interested some of the spectators even to tears. This circumstance serves to prove that the utmost care should be taken to prevent dancing from degenerating into the insinuating prelude to vice, as many of the experienced female performers on our different stages dress and exhibit their persons in a manner rather reprehensible, and at least remind us of the dancing-girls of the East, where sets of young and beautiful prostitutes, are taught the art of pleasing as a science, and to dance as a principal allurement. Some of those unfortunate beings are attached to the Gentoo temples, and the service of their priests, and the fascinations of several have been sufficiently powerful to attract the affections of chiefs and princes; others have acquired great wealth, and in the neighbourhood of Goa, is a village founded by them, where they reside and attend the rich when they choose to send for them to their voluptuous entertainments. These wantons array themselves in the utmost splendour and extravagance, and are certainly agreeable objects in the estimation of their countrymen; but Europeans differ greatly in their opinions respecting their persons and dances, some pronouncing their movements merely lascivious, and others graceful and dangerous. These observations are the more necessary since dancing has become a favourite spectacle at our theatres, and as many of the grand ballets are attended with a considerable degree of pathos and effect, though frequently degraded by the extremity of gesticulation and distortion of the limbs, which can only be applauded for their difficulty, as they are directly opposite to the true principles of the art founded on ease, grace, and agility.

Rope dancing, now classed with the low amusements of a fair, or theatres of the minor description, is of considerable antiquity, and an art very difficult to acquire, as it is almost impossible even to stand on the narrow diameter of a rope, extended several feet from the ground, without the utmost correctness of vision, and the total absence of apprehension; when this circumstance is recollected, it must be allowed that proficients in rope dancing, deserve the applause they universally obtain, particularly when they unite their agile springs, with graceful movements of the arms and legs, and throw themselves on their backs at length on the rope, turn suddenly round, leap over garters, pass through hoops, or ascend the steep line of the rope to the spot where it is fastened.

DANÆA, in botany, a genus of the Cryptogamia Filices class and order: fructification oblong, linear, transversely immersed in the front, parallel, many celled; cells in a double row, opening upwards; seeds numerous, very minute. There are two species, *viz.* the nodosa and alata.

DANEGELT, a tax, or tribute on every hide of land, imposed on our ancestors the Saxons, by the Danes, on their frequent invasions, as the arbitrary terms of peace and departure. It was first imposed as a continual yearly tax upon the whole nation, under King Ethelred. It was levied by William I. and II. but was released by Henry I. and finally abolished by King Stephen. No church, or church-land paid the danegelt, because, as is set forth in the ancient Saxon law, the people of England placed more confidence in the prayers of the church, than in any military defence they could make.

DAPHNE, in botany, a genus of the Octandria Monogynia class and order. Natural order Vepreculæ. Thymelææ, Jussieu. Essential character: calyx none; corolla four-cleft, corollaceous, withering; including the stamens; berry one-seeded. There are 28 species: these are shrubs about five feet high. D. Mezereum. Mezereon is a strong woody plant, putting forth branches on every side, so as to form a regular head. The flowers come out very early in the spring, before the leaves, in clusters all round the shoots of the former year. The leaves are smooth and entire, of a pale green colour, about two inches long and three quarters of an inch broad. It is a native of Lapland, Sweden, Denmark, Germany, Switzerland, France, and Great Britain.

DARAPTI, among logicians, one of the modes of syllogisms of the third figure, whose premises are universal affirmatives, and the conclusion is a particular affirmative: thus,

DAR- Every body is divisible;
AP- Every body is a substance;
TI. Therefore some substance is divisible.

DAREA, in botany, a genus of the Cryptogamia Filices class and order. Fructification in scattered nearly marginal lines:

involucre originating laterally from a vein, opening towards the margin. There are nine species.

DARII, in logic, one of the modes of syllogism of the first figure, wherein the major proposition is an universal affirmative, and the minor and conclusion particular affirmatives: thus,

DA- Every thing that is moved is moved by another;
RI- Some body is moved:
I. Therefore some body is moved by another.

DASYPUS, the armadillo, in natural history, a genus of Mammalia of the order Bruta. Generic character: no tusks; grinders short and cylindrical, and seven or eight in each jaw; body covered with a shelly armour, intersected by circles. These animals chiefly inhabit South America, where they burrow like rabbits in the ground, and live principally upon roots and fruits. They exhibit a singular difference from other quadrupeds, in that testaceous substance which covers them completely, and yet is so admirably adapted to their frame by its minute intersections, as by no means to interfere with flexibility or quick movement. When attacked, they roll themselves up into the compactness of a ball; thus presenting to the enemy almost impenetrable armour. They repose by day, and at night quit their habitations for food. They are perfectly inoffensive. In a state of confinement they will devour with considerable appetite animal food, for which in a state of nature they do not appear to have any relish. They drink most copiously, and are often found extremely fat. They are regarded as a very great luxury for the table, and are not unfrequently dug from their burrows to be sold for food: for this purpose, however, they should always be taken young. Their claws are of uncommon size and strength, and enable them to form their subterraneous habitations with extreme facility. Shaw reports, that the female produces three or four times in a year; and Gmelin states, that she produces every month. It is ascertained, therefore, that they are highly prolific. It is the practice of naturalists to define the different species by the different number of testaceous circles in the body. Gmelin enumerates ten species, and Shaw six. This extraordinary variety among quadrupeds deserves the particular attention of naturalists, who do not appear to have so clearly defined the several species, or to have collected so many particulars of the manners and habits of the animal in general as its most singular structure excites a desire to be informed of.

DATA, among mathematicians, a term for such things or quantities as are given or known, in order to find other things thereby that are unknown. Euclid uses the word data (of which he hath a particular tract) for such spaces, lines, and angles as are given in magnitude, or to which we can assign others equal. The data of Euclid is the first in order of the books that have been written by the ancient mathematicians, to facilitate and promote the method of resolution and analysis. In algebra, the given quantities, or data, are expressed by the first letters of the alphabet, and the unknown quantities by the last letters; thus, if the problem be, from the sum and product of two quantities given, to find the quantities themselves, the quantities are represented by y and z; and $y+z=a$ the sum given, and $yz=b$, the product given. From the primary use of the word data in mathematics, it has been transplanted into other arts, where it expresses any quantity, which, for the sake of a present calculation, is assumed as true, without stopping to give a proof of it, called also the given quantity, number, or power. Hence also such things as are known are now frequently by physical writers denominated data.

DATE, in law, is the description of the day, month, year of our Lord, and year of the reign of the King, in which a deed or other writing was made. Anciently deeds had no dates but only of the month and year, and now, if in the date of any deed the year of our Lord is right, though the year of the King's reign be wrong, it shall not hurt the same. A deed is good, though it has no date of the day, or if that be mistaken, or though it contains an impossible date; but then he that pleads such a deed must set forth the time when it was delivered: for every deed or writing has a date in law, and that is the day of the delivery; and where there is none, a plaintiff, it is said, may count it of any date.

In writings of importance, the date should be written in words at length.

In letters, it is usually written in figures.

An ante-date is a date prior to the real time when the instrument was signed.

A post-date is that posterior to the real time when the instrument was passed.

DATE. See PHŒNIX.

DATISCA, in botany, a genus of the

Dioecia Dodecandria class and order. Essential character: male, calyx five-leaved; corolla none; anthers sessile, long, fifteen: female, calyx two-toothed; corolla none; styles three; capsule triangular, three-horned, one-celled, pervious, many-seeded, inferior. There are two species; *viz.* D. cannabina, smooth stalked bastard hemp, found in Candia; and D. hirta, rough stalked bastard hemp, a native of Pennsylvania. These are tall upright herbs, with alternate unequally pinnate leaves. The flowers are in spiked racemes, axillary, with one bracte; the flower is apetalous; fruit is inferior, and contains many seeds.

DATISI, in logic, a mode of syllogisms in the third figure, wherein the major is an universal affirmative, and the minor and conclusion particular affirmative propositions. For example,

DA- All who serve God are kings;
TI- Some who serve God are poor;
SI. Therefore some who are poor are kings.

DATURA, in botany, English *thorn-apple*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel-form, plaited; calyx tubular, angular, deciduous; capsule four-valved. There are eight species; these are all herbs and annual, excepting one; the flowers and branches are solitary, they have a strong narcotic smell; most of the species, coming from hot countries, require the protection of a stove or glass case.

DAVALLIA, in botany, a genus of the Cryptogamia, Filices. Fructifica in roundish distinct dots near the margin; involucre membraneous from the surface, half-hooded, distinct, somewhat truncate, opening toward the margin. There are eighteen species.

DAVIESIA, in botany, a genus of the Decandria Monogynia class and order. Calyx angular, simple, five-cleft; corolla papilionaceous; stigma simple, acute; legume compressed, one-seeded. One species, D. australasia, described by Dr. Smith in the fourth Vol. of the "Linn.Transactions."

DAVIT, in a ship, that short piece of timber, with a notch at one end, wherein, by a strap, hangs the fish-block. The use of this block is to help up the fluke of the anchor, and to fasten it at the ship's bow, or loof. The davit is shiftable from one side of the ship to the other, as there is occasion. There is also a small davit in the ship's boat, that is set over her head with a shiver, in which is brought the buoy rope, wherewith to weigh the anchor; it is made fast to the carlings in the boat's bow.

DAUCUS, in botany, English *carrot*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: corolla subradiate, all hermaphrodite; fruit hispid, with hairs. There are seven species, of which we shall mention D. carota, wild carrot, or birds nest, this in its wild state has a slender, hard, brownish, fusiform root; the stem is two feet high, upright, grooved, with alternate branches, which are long, commonly from six to ten inches; they have one leaf except the primary or terminating one, which is naked; and have a single umbel of flowers at top; the universal umbel has sometimes from thirty to forty unequal rays; the middle rays being very short, the outer ones above an inch long: the flowers are white, those in the middle tinged with purple, these are fertile, those in the circumference, which are irregular and larger, are frequently neuter, or have pistils only: the fruit is spheroidal, composed of plano-convex seeds, on the back of which are four membranaceous narrow crests, pectinated with linear, setaceous, innocuous, flexible teeth. The carrot, is commonly cultivated in gardens for the kitchen; the different varieties of it are, in some places, esteemed, in London the orange carrot is preferred to all others.

DAY. In common language, the day is the interval of time which elapses from the rising to the setting of the sun; the night is the interval that the sun continues below the horizon. The astronomical day embraces the whole interval which passes during a complete revolution of the sun. It is the interval of time which passes from 12 o'clock at noon till the next succeeding noon. It begins when the sun's centre is on the meridian of that place. It is divided into 24 hours, reckoning in a numerical succession from 1 to 24: the first 12 are sometimes distinguished by the mark P.M. signifying post meridiem, or afternoon; and the latter 12 are marked A.M. signifying ante meridiem, or before noon. But astronomers generally reckon through the 24 hours from noon to noon; and what are by the civil or common way of reckoning called morning hours, are by astronomers reckoned in the succession from 12, or midnight to 24 hours. Thus, 9 o'clock in the morning of February 14th, is, by astrono-

Fig. 1. Castor fiber: beaver _ Fig. 2. Cavia cobaya: guinea pig _ Fig. 3. C. paca spotted cavy _ Fig. 4. C. aguti: long nosed cavy _ Fig. 5. Dasypus sexcinctus six banded armadillo _ Fig. 6. D. novemcinctus: nine banded armadillo.

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mers, called February the 13th, at 21 hours. An astronomical day is somewhat greater than a complete revolution of the heavens, which forms a sidereal day. For if the sun cross the meridian at the same instant with a star, the day following it will come to the meridian somewhat later than the star, in consequence of its motion eastward, which causes it to leave the star; and after a whole year has elapsed it will have crossed the meridian just one time less than the star. A sidereal day is less than the solar day, for it is measured by 360°; whereas the mean solar day is measured by 360° 59′ 8″ nearly.

If an astronomical day be = 1, then a sidereal day is = 0.997269722; or the difference between the measures of a mean solar day and a sidereal day, *viz.* 59′ 8″, reduced to time, at the rate of 24 hours to 360°, gives 3′ 56″; from which we learn that a star which was on the meridian with the sun on one noon, will return to that meridian, 3′ 56″, previously to the next noon: therefore, a clock which measures mean days by 24 hours, will give $23^h\ 56^m\ 4^s$, for the length of a sidereal day.

Astronomical, or solar days, as they are also called, are not equal. Two causes conspire to produce their inequality, namely, the unequal velocity of the sun in his orbit, and the obliquity of the ecliptic. The effect of the first cause is sensible. At the summer solstice, when the sun's motion is slowest, the astronomical day approaches nearer the sidereal, than at the winter solstice when his motion is most rapid. To conceive the effect of the second cause it is necessary to recollect that the excess of the astronomical day above the sidereal is owing to the motion of the sun, referred to the equator. The sun describes every day a small arch of the ecliptic. Through the extremities of this arch suppose two meridian great circles drawn, the arc of the equator, which they intercept, is the sun's motion for that day referred to the equator; and the time which that arc takes to pass the meridian is equal to the excess of the astronomical day above the sidereal. See TIME, *equation of.*

The nychthemeron is divided into twenty-four parts, called hours, which are of two sorts, equal and unequal, or temporary.

Different nations begin their day at a different hour: thus the Egyptians began their day at midnight, from whom Hippocrates introduced that way of reckoning into astronomy; and Copernicus and others have followed him: but the greatest part of astronomers reckon the day begun at noon, and so count 24 hours till the noon of the next day; and not twice 12 according to the vulgar computation. The method of beginning the day at midnight prevails also in Great Britain, France, Spain, and most parts of Europe. The Babylonians began their day at sun-rising, reckoning the hour immediately before its rising again the 24th hour of the day, from whence the hours reckoned in this way are called the Babylonic. In several parts of Germany they begin their day at sun-setting, and reckon on till it sets next day, calling that the 24th hour: these are generally termed Italian hours. The Jews also began their day at sun-setting; but then they divided it into twice 12 hours as we do, reckoning 12 for the day, be it long or short, and 12 for the night; so that their hours continually varying with the day and night, the hours of the day were longer than that of the night for one half year, and the contrary the other; from whence their hours are called temporary: those at the time of the equinoxes became equal, because then those of the day and night are so. The Romans also reckoned their hours after this manner; as do the Turks at this day. This kind of hours are called planetary, because the seven planets were anciently looked upon as presiding over the affairs of the world, and to take it by turns each of these hours, according to the following order: Saturn first, then Jupiter, Mars, the Sun, Venus, Mercury, and last of all the Moon: hence they denominated each day of the week from that planet whose turn it was to preside the first hour. Thus assigning the first hour of Saturday to Saturn, the second will fall to Jupiter, the third to Mars, and so the twenty-second will fall to Saturn again, and therefore the twenty-third to Jupiter, and the last to Mars: so that on the first hour of the next day it will fall to the Sun to preside; and by the like manner of reckoning the first hour of the next will fall to the Moon; of the next, to Mars; of the next, to Mercury, of the next, to Venus: hence the days of the week came to be distinguished by the Latin names of *Dies Saturni, Solis, Lunæ, Martis, Mercurii, Jovis,* and *Veneris;* and among us, by the names of Saturday, Sunday, Monday, &c.

DAY, in a legal sense, relates to the day of appearance of parties, or the continuance of suits where a day is given, &c. See ESSOIN.

In real actions there are common days and special days given by the judges in an assise, &c.

Days *in bank*, are days set down by statute or order of the court, when writs shall be returned, or when the party shall appear on the writ served. They say also, if a person be dismissed without day, he is finally discharged.

Days *of grace*, are those granted by the court at the prayer of the defendant, or plaintiff, in whose delay it is.

Days *of grace*, in commerce, are a customary number of days allowed for the payment of a bill of exchange, &c. after the same becomes due.

Three days of grace are allowed in England; ten in France and Dantzic; eight at Naples; six at Venice, Amsterdam, Rotterdam, and Antwerp; four at Frankfort; five at Leipsic; twelve at Hamburg; six in Portugal; fourteen in Spain; thirty in Genoa, &c.

Day *light*, in our law; sometime after sun-setting, and before sun-rising, being accounted part of the day, when the hundred is liable for any robberies committed within that time.

Day's *work*, in naval affairs, the reckoning or account of a ship's course and distance, run during 24 hours, or from noon to noon, according to the rules of trigonometry. See Dead Reckoning.

DEACON, one of the three sacred orders of the Christian church. The word is sometimes used in the New Testament for any one that ministers in the service of God, in which sense bishops and presbyters are styled deacons; but in its restrained sense it is taken for the third order of the clergy, as appears from the concurrent testimony of ancient writers, who constantly stile them ministers of the mysteries of Christ, ministers of episcopacy and the church, and the like.

DEAD *men's eyes*, in the sea language, a kind of blocks with many holes in them, but no sheevers, whereby the shrouds are fastened to the chains: the crow-feet reeve also through these holes; and in some ships the main stays are set taught in them; but then they have only one hole, through which the lanyards are passed several times.

Dead *nettle*. See Lamium.

Dead *reckoning*, in navigation, the calculation made of a ship's place by means of the compass and log; the first serving to point out the course she sails on, and the other the distance run. From these two things given, the skilful mariner, making proper allowances for the variation of the compass, lee-way, currents, &c. is enabled, without any observations of the sun or stars, to ascertain the ship's place tolerably well.

DEAFNESS, the state of a person who wants the sense of hearing; or, the disease of the ear, which prevents its due reception of sounds. Deafness generally arises either from an obstruction or a compression of the auditory nerve; or from some collection of matter in the cavities of the inner ear; or from the auditory passage being stopped up by some hardened excrement; or, lastly, from some excrescence, a swelling of the glands, or some foreign body introduced within it. Those born deaf are also dumb, as not being able to learn any language, at least in the common way. However, as the eyes in some measure serve them for ears, they may understand what is said by the motion of the lips, tongue, &c. of the speaker; and even accustom themselves to move their own, as they see other people do, and by this means learn to speak. Thus it was that Dr. Wallis taught two young gentlemen, born deaf, to know what was said to them, and to return pertinent answers. Digby gives us another instance of the same, within his own knowledge; and there was a Swiss physician lately living in Amsterdam, one John Conrad Amman, who effected the same in several children born deaf with surprising success.

In the "Phil. Trans." No. 312, we have an account by Mr. Waller, R. S. Secretary, of a man and his sister, each about 50 years old, born in the same town with Mr. Waller, who had neither of them the least sense of hearing; yet both of them knew, by the motion of the lips only, whatever was said to them, and would answer pertinently to the question proposed. It seems they could both hear and speak when children, but lost their sense afterwards: whence they retained their speech, which, though uncouth, was yet intelligible. Such another instance is related by Bishop Burnet of a young woman. "At two years old, they perceived she had lost her hearing; and ever since, though she hears great noises, yet hears nothing of what is said to her: but by observing the motions of the mouth and lips of others, she acquired so many words, that out of these she has formed a sort of jargon, in which she can hold con-

versation whole days with those that can speak her language. She knows nothing that is said to her, unless she see the motion of their mouths that speak to her, so that in the night they are obliged to light candles to speak to her. One thing will appear the strangest part of the whole narration: she has a sister, with whom she has practised her language more than with any body else; and in the night, by laying her hand on her sister's mouth, she can perceive by that what she says, and so can discourse with her in the dark."

It is observable, that deaf persons, and several others thick of hearing, hear better and more easily if a loud noise be raised at the time when you speak to them; which is owing, no doubt, to the greater tension of the ear-drum on that occasion. Dr. Wallis mentions a deaf woman, who, if a drum were beat in the room, could hear any thing very clearly; so that her husband hired a drummer for a servant, that by this means he might hold conversation with his wife. The same author mentions another, who, living near a steeple, could always hear very well if there was a ringing of three or four bells, but never else. See DUMBNESS.

DEAL, a thin kind of fir planks, of great use in carpentry: they are formed by sawing the trunk of a tree into a great many longitudinal divisions, of more or less thickness, according to the purposes they are intended to serve. Deals are rendered much harder by throwing them into salt water as soon as they are sawed, keeping them there three or four days, and afterwards drying them in the air or sun; but neither this nor any other method yet known, will preserve them from shrinking. Deals are imported into this country from Christiana, and other parts of Norway; from Dantzic, and various parts of Prussia; from St. Petersburg, Archangel, Narva, Memel, &c. They are sold by the piece, or by the standard hundred, or by the long hundred of 120. A standard, or reduced deal, is one inch and a half thick, eleven inches wide, and twelve feet long.

DEAN, an ecclesiastical dignitary in cathedral and collegiate churches, and head of the chapter. As there are two foundations of cathedral churches in England, the old and the new, so there are two ways of creating deans. Those of the old foundation, founded before the suppression of monasteries, as the deans of St. Paul's, York, &c. are raised to that dignity much after the manner of bishops, the King first sending his congé d'elire, the chapter electing, and the King granting his royal assent, the bishop confirms him, and gives his mandate to install him. Those of the new foundation, whose deanries were raised upon the ruins of priories and convents, such as the deans of Canterbury, Durham, Ely, Norwich, Winchester, &c. are donative, and installed by virtue of the King's letters patent, without either election or confirmation. Canonists distinguish between deans of cathedral and those of collegiate churches. The first, with their chapter, are regularly subject to the jurisdiction of the bishop. As to the latter, they have usually the contentious jurisdiction in themselves, though sometimes this belongs to them in common with the chapter. There are cathedral churches which never had a dean, and in which the bishop is head of the chapter, and in his absence the archdeacon: such are the cathedrals of St. David and Landaff. There are also deans without a chapter, as the dean of Battle in Sussex, dean of the arches, &c. and deans without a jurisdiction, as the dean of the chapel royal. In this sense the word is applied to the chief of certain peculiar churches or chapels.

DEAN *and chapter*, are the bishop's council to assist him in the affairs of religion, and to assent to every grant which the bishop shall make to bind his successors. As a deanry is a spiritual dignity, a man cannot be a dean and prebendary of the same church.

DEATH. Physicians usually define death by a total stoppage of the circulation of the blood, and a cessation of the animal and vital functions consequent thereon; as respiration, sensation, &c.

An animal body, by the actions inseparable from life, undergoes a continual change. Its smallest fibres become rigid; its minute vessels grow into solid fibres, no longer pervious to the fluids; its greater vessels grow hard and narrow; and every thing becomes contracted, closed, and bound up; whence the dryness, immobility, and extenuation, observed in old age. By such means, the offices of the minuter vessels are destroyed; the humours stagnate, harden, and at length coalesce with the solids. Thus are the subtilest fluids in the body intercepted and lost, the concoction weakened, and the reparation prevented; only the coarser juices continue to run slowly through the greater vessels, to

the preservation of life, after the animal functions are destroyed. At length, in the process of these changes, death itself becomes inevitable, as the necessary consequence of life. But it is rare that life is thus long protracted, or that death succeeds merely from the decays and impairment of old age. Diseases, a long and melancholy train, cut the work short.

The signs of death are in many cases very uncertain. Between life and death the shade is often so very undistinguishable, that even all the powers of art can scarcely determine where the one ends and the other begins. The colour of the visage, the warmth of the body, and suppleness of the joints, are but uncertain signs of life still subsisting; while, on the contrary, the paleness of the complexion, the coldness of the body, the stiffness of the extremities, the cessation of all motion, and the total insensibility of the parts, are but uncertain marks of death begun. In the same manner, also, with regard to the pulse and breathing; these motions are so often kept under, that it is impossible to perceive them. By bringing a looking-glass near to the mouth of the person supposed to be dead, people often expect to find whether he breathes or not. But this is a very uncertain experiment; the glass is frequently sullied by the vapour of the dead man's body; and often the person is still alive, though the glass is no way tarnished. In the same manner, neither burning nor scarifying, neither noises in the ears nor pungent spirits applied to the nostrils, give certain signs of the discontinuance of life; and there are many instances of persons who have endured them all, and afterwards recovered without any external assistance, to the astonishment of the spectators. This ought to be a caution against hasty burials, especially in cases of sudden death, drowning, &c.

All our first associations with the idea of death are of the disgustful and alarming kind; and they are collected from all quarters, from the sensible pains of every sort, from the imperfection, weakness, loathsomeness, corruption, and disorder, where disease, old age, death, animal or vegetable, prevail, in opposition to the beauty, order, and lustre of life, youth, and health, from the shame and contempt attending the first, in many instances; whereas the last are honourable, as being sources of power and happiness, the reward of virtue, &c., and from the sympathetic passions in general. And it is necessary, that the heedlessness and inexperience of infancy and youth should be guarded by such terrors, and their headstrong appetites and passions curbed, that they may not be hurried into danger and destruction before they are aware. It is proper, also, that they should form some expectations with respect to, and set some value upon, their future life in this world, that so they may be better qualified to act their parts in it, and make the quicker progress to perfection during their passage through it.

Death *watch*, in natural history, a little insect famous for a ticking noise like the beat of a watch, which the vulgar have long taken for a presage of death in the family where it is heard: an error that cannot be too often confuted by facts. There are two kinds of death-watches. Of the first we have a good account in the Phil. Trans. It is a small beetle, half an inch long, of a dark brown colour, spotted; having pellucid wings under the vagina, a large cap or helmet on the head, and two antennæ proceeding from beneath the eyes, and doing the office of proboscides. The part it beats with, the writer observes, was the extreme edge of the face, which he calls the upper-lip, the mouth being protracted by this bony part, and lying underneath out of view. This account is confirmed by Dr. Derham; with the difference, that instead of ticking with the upper lip, he observed the insect to draw back its mouth, and beat with its forehead. That author had two death watches, a male and a female, which he kept alive in a box several months, and could bring one of them to beat whenever he pleased, by imitating its beating. From some circumstances the ingenious author concludes those pulsations to be the way whereby these insects woo one another.

The second kind of death watch is an insect in appearance quite different from the first. The former only beats seven or eight strokes at a time, and quicker; the latter will beat some hours together without intermission; and his strokes are more leisurely, and like the beat of a watch. This latter is a small greyish insect, much like a louse when viewed with the naked eye. It is very common in all parts of the house in the summer months: it is very nimble in running to shelter, and shy of beating when disturbed, but will beat very freely before you, and also answer the beating, if you can view it without giving it

disturbance, or shaking the place where it is, &c.

DEBENTURE, a term of trade used at the custom-house for a kind of certificate signed by the officers of the customs, which entitles a merchant exporting goods to the receipt of a bounty or drawback. All merchandises that are designed to be taken on board for that voyage being entered and shipped, and the ship being regularly cleared out, and sailed out of port on her intended voyage, debentures may be made out from the exporter's entries, in order to obtain the drawbacks, allowances, bounties, or premiums; which debentures for foreign goods are to be paid within one month after demand. And in making out these debentures, it must be observed, that every piece of vellum, parchment, or paper, containing any debenture for drawing back customs or duties, must, before writing, be stamped, and pay a duty.

DEBENTURE, in military affairs, is a kind of warrant, given in the office of the board of ordnance, whereby the person whose name is thereby specified, is entitled to receive such a sum of money as by former contract had been agreed on. Debenture, in some acts of parliament, denotes a kind of bond or bill, by which the government is charged to pay the soldier, creditor, or his assigns, the money due on auditing the account of his arrears. The payments of the board of ordnance for the larger services at home are always made by debentures; and the usual practice has been to make those payments, which are said to be in course of office, at a period which is always something more than three months after the date of each debenture.

DEBET, among merchants, signifies the sums due to them for goods sold on credit, for which they have charged their journal or ledger. It is more particularly understood of the remainder of debts, part of which has been paid on account.

DEBET, among book-keepers, is used to express the left hand page of the ledger, to which are carried all articles supplied or paid, on the subject of an account.

DEBT, a sum due from one person to another, in consequence of work done, goods delivered, or money lent, for which reimbursement has not been made. The non-payment in these cases, is an injury, for which the proper remedy is by action of debt, to compel the performance of the contract, and recover the special sum due.

DEBT, *national*, the engagement entered into by a government, to repay at a future period money advanced by individuals for the public service, or to pay the lenders an equivalent annuity. National debts have arisen from the necessity of obtaining larger sums of money than could be raised at the time, they were wanted by direct contributions; and often, when it would not have been absolutely impossible to raise the requisite sum if a heavy tax had been imposed, and strictly levied, it has been deemed more prudent to avoid the evils attendant on such a measure by the less obnoxious expedient of a loan. In most countries, the subordinate governors, to whom is generally consigned the task of providing for the public expenses, being desirous of popularity have shewn a great predeliction for this mode of obtaining money, as it enables them to support a profuse expenditure, without appearing to oppress the people in so great a degree as they otherwise must: the system of getting into debt, or the funding system, as it is generally called, from particular funds being usually appropriated for payment of interest on the debts contracted, has therefore been adopted by most of the states of Europe, by many of the colonies, and by the American republic.

The persons who lend the money which a government has occasion to borrow, generally make a profit by it, but nothing is brought into the country, nor the least addition made to its total wealth by a transaction of this kind; whatever therefore is gained by any individual concerned in it, must be taken from others, and as those who lend the money are persons already possessing considerable property, and those from whom the sums requisite for paying the interest or repaying any part of the principal is to be drawn, are the public at large, it is evident that all transactions of this nature contribute to increase the existing disparity in the condition of the different classes of the community, and consequently that the natural tendency of the funding system, when made a constant resource, is, to destroy the intermediate ranks, and divide a nation into the two classes only, as unequal in number as in circumstances, of very rich and very poor. It may however be carried to a very great extent, without fully producing this effect, if counteracting circumstances exist sufficiently powerful to dissipate the gains of the rich nearly as fast as they are acquired, and

thus prevent a rapid accumulation of wealth. This has been the case in Great Britain; but although the great increase of necessary and fashionable expense has prevented the wealthy from becoming so enormously rich as they otherwise would have been, there can be little doubt that taken collectively, they are possessed of more property and income than the wealthy members of the community at any former period, and that the number of the poor is considerably augmented. In a state where taxation is general, the effects of the borrowing system are somewhat retarded, by the lenders themselves contributing to the taxes levied to pay them interest, and therefore the practice may be carried to a greater extent than in those states where particular classes, as the nobility or priesthood, are exempt from taxation, and under whose privileges the money lenders may shelter themselves from contributing their just proportion.

Most governments have begun to borrow upon their general credit, without assigning any particular fund for the payment of the debt; and when this resource has failed them, they have gone on to borrow upon assignments or mortgages of particular funds. What is called the unfunded debt of Great Britain, is contracted in the former of those ways; but this is a mode which never can be carried to a great extent without bringing the finances of a country into disorder; the other mode is subject to no limitation, while efficient funds can be found for securing the regular payments stipulated with the lenders. Borrowing on the security of particular funds, is done in two ways; sometimes the assignment or mortgage is made for a short period of time only, a year or a few years, for example; and sometimes for perpetuity. In the former case, the fund is supposed sufficient to pay, within the limited time, both principal and interest of the money borrowed; in the other, it is supposed sufficient to pay the interest only, which is either an annuity terminable at the end of a certain number of years, or a perpetual annuity which the government retains the liberty of redeeming at any time upon paying back the principal sum borrowed. When money is raised in the one way, it is said to be raised by anticipation; when in the other, by funding.

The great expense attending the modern system of warfare, appears to have created the necessity of contracting national debts; the practice originated in Italy, and was soon adopted in other countries, but it has been brought into a more regular system, and carried to a much greater extent in Great Britain, than in any other nation.

In the reign of King William, and during a great part of that of Queen Anne, before the practice of funding on perpetual annuities had become familiar, the greater part of the new taxes were imposed for a short period of time (for four, five, six, or seven years only) and the principal part of the grants of each year consisted of loans in anticipation of the produce of those taxes. The produce being frequently insufficient for paying, within the limited time, the principal and interest of the money borrowed, deficiencies arose; to make good which, it became necessary to prolong the original term. This expedient was repeated, and money was sometimes borrowed on a fund already anticipated for several years to come. Exchequer bills were issued, and lotteries introduced, but all these temporary means were found inadequate to the rapid increase of the public expenditure; which of course soon caused an accumulation of public debts; and as the interest payable to the public creditors was frequently some time in arrear, public credit was occasionally reduced to a very low ebb, and apprehensions were entertained that the public debt had already become too heavy a burthen for the country to prosper under.

In the year 1711 a project was formed for relieving the government from the financial difficulties under which it laboured, by permitting the proprietors of various debts and arrears, amounting to 8,971,325*l.* to subscribe them towards raising the capital of a company formed for carrying on a trade to the South Seas. The actual capital of the company was 9,177,967*l.* 15*s.* 4*d.* which for the further accommodation of government was increased in 1715 to ten millions.

The total amount of the national debt on the 31st of December, 1716, was 48,364,501*l.* 8*s.* 4*d.* which, on the opening of the following session of parliament, was mentioned in the King's speech and the Commons' address, as an insupportable weight, and the government appears to have thought it necessary to concert seriously such measures as might lay the foundation of an effectual plan for its reduction. In consequence of this disposition, all the existing taxes, except the land and malt, were made perpetual; and, having been distributed into three classes, called the Aggre-

gate, South Sea, and General Funds, the surplusses remaining, after satisfying the previous charges upon these respective funds, were formed into a separate fund, called the Sinking Fund, for the express purpose of discharging the principal and interest of such national debts and incumbrances as were incurred before the 25th of December, 1716. See SINKING FUND.

The memorable South Sea scheme, in the year 1720, was to have furnished a considerable sum to be employed in the reduction of the public debts; instead of which it increased their amount by an addition to the capital of 3,034,769*l.* 11*s.* 11*d.* while the annual charge was rather augmented than diminished by the allowance for management on the increased capital. The reduction of a part of the interest was, however, secured; and as the company's capital was redeemable, a further reduction of interest might be effected at a future period; but this depended on future circumstances, whereas had the terminable annuities which were converted into redeemable perpetuities by this scheme remained in their original state, there was a certainty of their expiring at a fixed period.

In 1727 the interest on 37,738,007*l.* of the public debts was reduced from 5 to 4 per cent. which produced an important addition to the Sinking Fund. An opinion, however, began to prevail, that the public debts had increased since the establishment of the fund, and that this provision was inadequate to the purpose for which it was designed. This occasioned the publication of an excellent essay on the public debts, which has been generally ascribed to Sir Nath. Gould, in which it was clearly shewn, that although from the South Sea subscription, and from several articles being brought to account which were actually due before the 25th of December, 1716, there was an appearance of increase, the debt had in reality been diminished, and that from the great addition now made to the Sinking Fund by the reduction of interest, it would, if not diverted to any other purpose, discharge all the debts then existing in about 56 years, or with a further reduction of interest in a shorter period.

The application of the sinking fund to its original object was, however, of short duration: in 1733 half a million was taken from it towards the supplies; larger sums were taken in the following years, and the whole amount paid off by the fund, from its establishment to the year 1739, was only 8,328,354*l.* leaving the total amount of the national debt 47,314,829*l.* The war which began in this year increased the debt to 78,293,313*l.* the interest on which amounted to 3,061,004*l.* per annum; but the rise in the price of the public funds on the peace enabled government, in 1749, to lessen the annual charge, by reducing the interest on 57,703,475*l.* from 4 to 3½ per cent. till the 25th December, 1757, and thence 3 per cent. This reduction produced a saving of 612,735*l.* per annum; and with the salt duties, amounting to about 220,000*l.* per annum, formed another important addition to the sinking fund, the yearly produce of which, on an average of ten years previous to this augmentation, was 1,356,578*l.*; an income sufficient to have effected a very considerable diminution of the public debts, if it had been strictly applied to the purpose for which it was designed; but being constantly taken towards the yearly supplies, scarce any progress was made in the reduction of the debt.

The total amount of the national debt at the commencement of the seven years' war, in 1756, was 74,980,886*l.*; and as the increased expenditure beyond the charge of preceding wars, which is one of the inevitable consequences of perpetuating taxes, rendered it necessary to borrow larger sums than had ever before been raised on loan, the debt increased rapidly, and at the end of the war, including the loan of 1763, and a valuation of the terminable annuities, it amounted to 136,367,757*l.*, exclusive of the unfunded debt.

After the peace in 1763, the income of the sinking fund increased considerably. The causes of this were partly the falling in of life annuities, and the greater productiveness of the taxes arising from the increase of commerce and population. But the principal cause was the falling in of the interest of about ten millions and a half of the public debt, which was discharged during the twelve years of peace ending with 1775. This diminution of the public debt could not, however, be said to be made by the sinking fund, as other sources supplied the principal part of the amount: these were, a contribution from the East India Company of 400,000*l.* per annum, begun in 1768, and continued for five years; the profits of ten lotteries; the composition agreed to be paid by the King of France for the maintainance of French prisoners; monies arising from the sale of French prizes taken before the declaration of war, and other

extraordinary receipts, amounting in the whole to above eight millions. The sinking fund, therefore, did not pay off more than two millions and a half, the rest of its produce having been employed in bearing the expences of the peace establishment, which during that period were not much less than double what they had been in any former period.

At the commencement of the American war, then considered as little more than a partial insurrection, which would be speedily suppressed, the resources and perseveance of the colonists were much underrated: it was not, therefore, deemed necessary to incur any great expence for the purpose of subduing them; but when the interference of France extended the operations of the war in all directions, very serious exertions became requisite, and the expenditure was in consequence augmented far beyond its amount in former wars. The sums which it was necessary to borrow thus increased from two millions to five, seven, and twelve millions, and in 1782 the loan was thirteen millions and a half. The apparent magnitude of the debt was also much increased by the practice of entitling the subscribers to the loans to a larger capital of stock than the money advanced, by which means, for the total sum of 75,500,000*l.* borrowed during this war, including the loan of 1784, a debt was created of 97,400,000*l.*, exceeding the money borrowed by 21,900,000*l.* The interest payable on the whole amounted to 4,119,125*l.* per annnum, being equal to 5*l.* 9*s.* 1*d.* per cent on the sums borrowed. In addition to these sums, a very considerable amount of navy debt was funded after the conclusion of the war, which being properly part of the expences of it, makes the total debt incurred by the American war amount to 115,267,992*l.*, and the interest payable thereon 5,012,562*l.* per annum.

The total amount of the national debt, funded and unfunded, including a valuation of the terminable annuities at their current prices, was, on the 5th January, 1786, 268,100,379*l.* and the amount of the annual interest 9,512,232. At this period, the general conviction of the absolute necessity of some provision being made for the gradual reduction of the debt, induced government to propose the establishment of a new sinking fund, under regulations which rendered it a considerable improvement on the fund formerly established for the same purpose. But although the revenue was represented as sufficiently productive to furnish a considerable surplus for this purpose, which, with a few new taxes, would amount to a million per annum, it was found necessary in 1789 to borrow towards the supplies 1,002,140*l.* on a tontine, and 187,000*l.* on short annuities.

The total amount of the national debt, as it stood in 1792, being the year previous to the war with the French republic, was, according to the official statement, 238,231,248*l.*; but including the value of the terminable annuities, and the amount of the unfunded debt, the total was 268,267,272*l.* the annual interest and allowance for management on which amounted to 9,752,673*l.* From this amount, however, a deduction of more than eight millions is to be made for the stock which had been bought up at that period by the commissioners for the reduction of the debt. The magnitude of the sums borrowed in the course of the war which began in 1793, and the circumstance of the loans being chiefly made on 3 per cent. stock, caused an unparalleled increase of the national debt, attended with a great depreciation of the current prices of the public funds, which obliged the government to pay a very high interest for the money borrowed. In the years 1797 and 1798, it was found impracticable to raise the sums required without paying upwards of 6 per cent. interest, being a higher rate than had been paid on any money borrowed for the public service since the reign of Queen Anne. In the latter years of the war, large sums being levied by extraordinary taxes, the amount of the loans was rendered somewhat less than it otherwise must have been; they were still, however, of unprecedented magnitude: and in 1802, after the conclusion of the war, it was found necessary to borrow twenty-five millions more, to make good expenses of the war which had not been provided for. The total amount of the loans of this war was 200,500,000*l.* by which a debt was created of 310,424,323; to this must be added the amount of stock created by funding Navy and Exchequer bills, making the total amount of funded debt incurred by the war 351,125,730*l.* and the interest payable thereon 11,676,144*l.* per ann. This is exclusive of the Imperial loans, which there can be little doubt will remain a perpetual burthen to this country.

Among other financial occurrences of this period, the public debt of Ireland became in a great measure blended with that of Great Britain, from which it had hitherto

been entirely distinct. Ireland has constantly had a public debt from about the year 1760, but its amount was for many years very small in comparison with the magnitude to which it has since increased, as will appear from the following statement:

Years.	Debt.
1761	£ 223,438
1771	773,320
1781	1,551,704
1791	2,464,590
1801	31,950,656

The loans which became necessary in consequence of the war, were in the first year raised wholly in Ireland on 5 per cent. stock. In 1794, an inducement was offered to persons resident in England, to subscribe to the loans of Ireland, by making the dividends on part of the stock receivable at the Bank of England; and the same plan was followed in 1795 and 1796: but in 1797 the alarm of invasion, and the disturbed state of the country, rendered it impracticable for the government of Ireland to raise the loan necessary for the service of the year, without submitting to the most exorbitant terms; in consequence of which it was deemed preferable that it should be chiefly raised and funded in Great Britain, as part of the sum borrowed by the government of that country. The joint loans for Great Britain and Ireland were, therefore, raised as one sum, the interest of the whole being charged on the consolidated fund of Great Britain; and in this manner all the principal loans for the service of Ireland have been since raised, the government of that country remitting annually the interest, charges of management, and appropriation of one per cent. on the capital, in order to reimburse the payments made from the consolidated fund on this account.

The total amount of the funded debt of Ireland on the 5th of January, 1807, was 64,721,356*l.* 15*s.* the principal part of which, having been actually borrowed by the government of Great Britain, is included in the following statement, as with respect to the public creditors, the whole of the sums thus borrowed are the proper debt of Great Britain.

Statement of the National Debt of Great Britain at Midsummer, 1807.

	Capital. £.	s.	d.	Interest and Management. £.	s.	d.
Consolidated 5 per cent. annuities	46,674,742	1	8	2,354,740	14	9
5 per cent. annuities, 1797 and 1802	2,406,132	13	3	121,389	7	10
Consolidated 4 per cent. annuities	49,725,084	17	2	2,011,379	13	7
Reduced 3 per cent. annuities	164,705,570	6	5	5,015,284	12	3
Consolidated 3 per cent. annuities	406,116,201	18	5¼	12,366,238	6	11
Deferred 3 per cent. annuities	1,740,625	0	0			
3 per cent annuities, 1726	1,000,000	0	0	30,450	0	0
Bank of England	11,686,800	0	0	356,502	3	5
South Sea stock	3,662,784	8	6			
Old South Sea annuities	11,907,470	2	7	735,974	13	11
New South Sea annuities	8,494,830	2	10			
South Sea annuities, 1751	1,919,600	0	0	58,667	15	6
Value of the long annuities	21,245,367	16	0	1,151,510	9	1½
Ditto of the short annuities	211,519	12	10	423,039	5	9
Ditto of the life annuities	279,074	7	6	55,814	17	6
Annuities with survivorship, 1765	18,000	0	0	540	0	0
Tontine annuities, 1789	239,428	4	3	19,952	7	0¼
Funded debt	£732,033,231	11	5¼	£24,701,484	7	6¾
Navy, Victualling, and Transport debt	6,000,000	0	0			
Exchequer bills	12,000,000	0	0	630,000	0	0
Ditto for the bank charter	3,000,000	0	0			
Ordnance debt, Treasury bills, &c.	3,000,000	0	0			
Total funded and unfunded debt	£756,033,231	11	5¼	£25,331,484	7	6¾
Redeemed by the commissioners	117,581,858	0	0	3,316,252	14	9
Total unredeemed debt	£638,451,373	11	5¼	£22,015,231	12	9¾

The capital redeemed by the Commissioners for the reduction of the national debt, is given as it stood on the 1st of February, 1807, their accounts being made up to that period.

The statement is exclusive of the capital of Imperial 3 per cent. annuities, being 7,502,633*l.* 6*s.* 8*d.*; the dividends on which, amounting to 225,079*l.* per annum, and likewise the annuities for 25 years of 230,000*l.* per annum, have become as regular a charge upon the consolidated fund as any part of the debt of Great Britain.

For the terms on which the public debts have been contracted, see LOANS. For the particulars of the different funds of which they consist, and the mode of transacting business therein, see FUNDS.

DEBTS *and credits*, in military affairs. Every captain of a troop or company in the British service is directed to give in a monthly statement of the debts and credits of his men; and it is the duty of every commanding officer to examine each list, and to see that no injustice or irregularity has been countenanced or overlooked in this business.

DECAGON, in geometry, a plane figure with ten sides and ten angles: it is called a regular decagon, when all the sides and angles are equal.

If we suppose the radius of a circle to be r, then will $\sqrt{\frac{5}{4}r^2} - \frac{1}{2}r$, or $\sqrt{\frac{5-1}{2}} \times r$, be the side of a decagon inscribed in that circle. Again, supposing the side of a decagon to be 1, the area thereof will be 8.69; whence, as 1 to 8.69, so is the square of the side of any given decagon to the area of that decagon.

DECAGYNIA, in botany, the name of an order, or secondary division, in the class Decandria, of the sexual method, consisting of plants whose flowers are furnished with ten stamina, and the same number of styles. Neurada and American night-shade furnish examples.

DECALOGUE, the ten precepts or commandments delivered by God to Moses, after engraving them on two tables of stone.

DECANDRIA, in botany, the name of the tenth class in Linnæus's system, consisting of plants whose flowers, as the name imports, are furnished with ten stamina or male organs. This class, as well as the other classes in Linnæus's method that are compounded with a numeral, has another character, which is not expressed in the title, *viz.* that the flowers are all hermaphrodite, that is, have both stamina and pointals, which, according to our author, are the male and female organs of generation within the same covers. In this respect, the classes in question differ from the Monœcia and Diœcia of the same author, in which the male and female organs are separated; being placed, in the former, upon different parts of the same plant; in the latter, upon distinct plants. This observation merits attention, because character, which is the subject of it, is indispensably necessary; and a plant having ten, or any number of stamina, is not on that account to be referred to its respective numeral class, unless both male and female organs are found contained within the covers of the flower. To take an example from the class which we are now considering: the flowers of the curious exotic, papaw, or popo-tree, have ten stamina; and yet the plant cannot be arranged under the class Decandria, because the male and female parts are not only placed within different covers, but likewise produced upon distinct plants: the popo seed ripened by the female flowers producing both male and female trees. Besides the sexes of the flowers, it is necessary that the stamina be of an equal length and distinct; that is, neither joined at the bottom nor top; circumstances which would remove the plants in which they are found, to classes whose essential character is no ways connected with the number of the male and female organs.

The orders or secondary divisions in this numerous class are five, and take their name from the number of styles, or female organs. Fraxenilla, lignum vitæ, dwarf rose-bay, and strawberry-tree, have one style; soap-wort, and carnation, have two; cucubalus, viscous campion, and sand-wort, three; hog-plum, navel-wort, and houseleek, five; neurada, and American nightshade, ten.

Decandria is likewise the name of an order or secondary division in the classes Monadelphia, Diadelphia, Gynandria, and Diœcia, in all which, the classic character being unconnected with the number of stamina, that circumstance, properly enough, serves as a foundation for the secondary or subordinate division.

DECEM *tales*, in law, a writ that issues directed to the sheriff, whereby he is commanded to make a supply of jurymen, where a full jury does not appear on a trial at bar.

DECIDUUS, in botany, a term expressive of the second stage of duration in plants, but, like caducus, susceptible of different senses, according to the particular part of the plant to which it is applied. A leaf is said to be deciduus which drops in autumn; petals are deciduus which fall off with the stamina and pistillum; and this epithet is applied to such flower-cups as fall after the expansion, and before the dropping of the flower. This last is exemplified in berberry, and the flowers of the class Tetradynamia.

Most plants in cold and temperate climates shed their leaves every year. This happens in autumn, and is generally announced by the flowering of the common meadow saffron. The term is only applied to trees and shrubs; for herbs perish down to the root every year, losing stem, leaves, and all. All plants do not drop their leaves at the same time. Among large trees, the ash and walnut, although latest in unfolding, are soonest divested of them: the latter seldom carries its leaves above five months. On the oak and horn-beam the leaves die and wither as soon as the colds commence; but remain attached to the branches till they are pushed off by the new ones, which unfold themselves the following spring. These trees are doubtless a kind of evergreens; the leaves are probably destroyed only by cold; and, perhaps, would continue longer upon the plant, but for the force of the spring-sap, joined to the moisture.

With respect to deciduus trees, the falling off of the leaves seems principally to depend on the temperature of the atmosphere, which likewise serves to hasten or retard the appearance in question. An ardent sun contributes to hasten the dropping of the leaves. Hence, in hot and dry summers, the leaves of the lime-tree and horse-chesnut turn yellow about the 1st of September; whilst, in other years, the yellowness does not appear till the beginning of October. Nothing, however, contributes more to hasten the fall of the leaves than immoderate cold or moist weather in autumn; moderate droughts, on the other hand, serve to retard it. It deserves to be remarked, that an ever-green tree grafted upon a deciduus, determines the latter to retain its leaves. This observation is confirmed by repeated experiments, particularly by grafting the laurel, or cherry-bay, an ever-green, on the common cherry; and the ilex, or ever-green oak, on the oak.

DECIMAL *arithmetic*, the art of computing by decimal fractions.

Decimal *fraction*, that whose denominator is always 1, with one or more cyphers: thus, an unit may be imagined to be equally divided into 10 parts, and each of these into 10 more; so that by a continual decimal subdivision the unit may be supposed to be divided into 10, 100, 1000, &c. equal parts, called tenth, hundredth, thousandth parts of an unit. In decimal fractions, the figures of the numerator are only expressed, the denominator being omitted, because it is known to be always an unit with so many cyphers as there are places in the numerator. A decimal fraction is distinguished from an integer with a point prefixed, as .2 for $\frac{2}{10}$, .34 for $\frac{34}{100}$, .567 for $\frac{567}{1000}$, &c. The same is observed in mixed numbers, as 678.9 for $678\frac{9}{10}$, 67.89 for $67\frac{89}{100}$, 6.789 for $6\frac{789}{1000}$, &c.

Cyphers at the right hand of a decimal fraction alter not its value; for .5 or .50 or .5000 is each of them of the same value, equal to $\frac{5}{10}$, or $\frac{1}{2}$: but cyphers at the left hand, in a decimal fraction, decrease the value in a tenfold proportion; for .05 is $\frac{5}{100}$, .005 is $\frac{5}{1000}$, .0005 is $\frac{5}{10000}$, &c.

As the denominator of a decimal is always one of the numbers 10, 100, 1000, &c. the inconvenience of writing these denominators down may be saved, by placing a proper distinction before the figures of the numerator only, to distinguish them from integers, for the value of each place of figures will be known in decimals, as well as in integers, by their distance from the 1st or unit's place of integers, having similar names at equal distances, as appears by the following scale of places, both in decimals and integers:

&c.	6	6	6	6	6	6	6	6	6	6	6	6	6	&c.
	millions	hund. of thousands	tens of thousands	thousands	hundreds	tens	units	tenths	hundredths	thousandths	ten thousandths	hund. thousandths	millionths	

Decimal fractions are easily reduced into a common denominator, by making, or even supposing, all of them to consist of the same number of places; so .3, .45, .067, .0089, may be written thus, .3000 .4500, .0670, ,0089; all which consisting of four places, their common denominator is an unit with four cyphers, namely 10000.

Addition and subtraction of decimals are the same as in whole numbers, when the places of the same denomination are set under one another, as in the following examples :

To	34.25	From	16.5
Add	3.026	Subtract	.125
Sum	37.276	Rem.	16.375

In multiplication the work is the same as in whole numbers, only in the product; separate, with a point, so many figures to the right hand as there are fractional places both in the multiplicand and multiplier; then all the figures on the left hand of the point make the whole number, and those on the right a decimal fraction.

It is to be noted, that if there be not so many figures in the product, as ought to be separated by the preceding rule, then place cyphers at the left, to complete the number, as may be seen in *Ex.* 5.

Ex. 1. Mult.	456	*Ex.* 2. Mult.	45.6
by	21.3	by	21.3
	1368	Product	971.28
	456		
	912		
Product	9712.8		

Ex. 3.	Multiply	456
	by	0.213
	Product	97.128
Ex. 4.	Multiply	45.6
	by	0.213
	Product	9.7128
Ex. 5.	Multiply	0.0456
	by	0.213
	Product	0.0097128

In division the work is the same as in whole numbers, only in the quotient, separate, with a point, so many figures to the right hand for a decimal fraction, as there are fractional places in the dividend, more than in the divisor, because there must be so many fractional places in the divisor and quotient together, as there are in the dividend.

As division of decimal fractions is extremely difficult, especially with regard to the value of the figures of the quotient, we shall here give a general rule for ascertaining their values, *viz.*

Rule, place the first multiple of the divisor under the dividend, as in operations of common division; then will the unit's place of this multiple stand under such a place of the dividend, as the first significant figure of the quotient is to be; that is, the first significant figure of the quotient will be of the same name or value with the figure of the dividend which stands above the unit's place of the multiple.

This rule will hold in all cases. 1. When the number of decimals are equal in the divisor and dividend, the quotient will be integers, or whole numbers: for placing the first multiple of the divisor under the dividend, according to the rule. *Ex.* 1.

```
8.45 ) 295.75 ( 35
       25.35
        4225
        4225
```

The unit's place 5, is found to stand under 9, the place of tens in the dividend; so that 3, the first figure of the quotient, must be tens also, and 5, the next figure, units. 2. When the number of decimals in the dividend, exceed those in the divisor, as, *Ex.* 2.

```
34.3 ) 780.516 ( 32.12
       72.9
```

Where 2, the unit's place of the multiple of the divisor, stands under 8, the place of tens of the dividend; whence 3, the first figure of the quotient, must be tens also; and 2, the next figure, units; so that the remaining figures, 12, must be decimals. This is done, more shortly, by making as many figures of the quotient decimals, as there are more decimal places in the dividend than in the divisor. 3. When there are not so many decimal places in the dividend, as there are in the divisor, cyphers must be added to the right hand of the dividend, to make them equal: thus, to divide 192.1 by 7.684, as in *Ex.* 3.

```
7.684 ) 192.100 ( 25
        15.368
         38420
         38420
```

Add two cyphers to make the decimals equal; and, by the above rule, the quotient 25 will be found to be integers, as 5, the place of units, stands under 9, the place of

tens. 4. If after division there are not so many figures in the quotient as there ought to be decimal parts, supply this defect by prefixing cyphers to the quotient found: thus, in *Ex*. 4.

$$\begin{array}{l} 957\,)\,7.2540\,(\,.00758 \text{ nearly.} \\ \quad\; \underline{6.699} \\ \quad\;\; .5550 \\ \quad\;\;\; \underline{4785} \\ \quad\;\;\; .7650 \\ \quad\;\;\;\; \underline{7656} \end{array}$$

The quotient by division is found to be 758; and, by the above rule, the first figure, 7, ought to stand in the decimal place of thousandths, which it is made to do by prefixing two cyphers.

Vulgar fractions are reduced to decimals of the same value, by dividing the numerator by the denominator.

Thus, $\frac{1}{2} = \frac{1.0}{2} = .5$, and $\frac{3}{4} = \frac{3.00}{4} = .75$, and $\frac{2}{7} = \frac{2.000000, \&c.}{7} = .285714$, nearly.

DECIMAL *scales* are those which are decimally divided.

DECIMATE, in military affairs, is to choose by lot, one out of ten, either by way of punishment, or for the purpose of being employed upon some public work.

DECIPHERING, the art of finding the alphabet of a cypher. See CYPHER, and DIPLOMATIC CHARACTERS.

DECK *of a ship* is a planked floor from stem to stern, upon which the guns lie, and where the men walk to and fro. Great ships have three decks, first, second, and third, beginning to count from the lowermost. Half deck reaches from the mainmast to the stem of the ship. Quarter-deck is that aloft the steerage, reaching to the round-house. See SHIP.

DECLARATION, is a shewing in writing the grief and complaint of the demandant, or plaintiff, against the defendant, or tenant, wherein he is supposed to have done some wrong. And this ought to be plain and certain, both because it impeaches the defendant, and also compels him to answer thereto. It is also an exposition of the writ, with the addition of time, circumstances, &c. and must be true as well as clear, for the court will not take things in it by implication; and it sets forth the names both of the plaintiff and defendant, the nature and cause of the action, &c. and the damage received. Such a declaration in an action real is termed a count, and it is essential, that the count or declaration ought to contain demonstration, declaration, and conclusion; and in the conclusion the plaintiff ought to aver, and offer to prove his suit, and shew the damages he has sustained by the wrong done him. Declaration must be certain: containing, 1. Such sufficient certainty whereby the court may give a peremptory and final judgment upon the matter in controversy. 2. The defendant may make a direct answer to the matter contained therein. 3. That the jury, after issue joined, may give a complete verdict thereupon. 4. No blank, or space, to be left therein.

DECLARATION *of war*, a public proclamation made by the herald at arms to the members or subjects of a state, declaring them to be at war with some foreign power, and forbidding all and every one to aid or assist the common enemy at their peril.

DECLENSION, in grammar, an inflexion of nouns according to their divers cases, as nominative, genitive, dative, &c. It is a different thing in the modern languages, which have not properly any cases, from what it is in the ancient greek and latin. With respect to languages, where the nouns admit of changes, either in the beginning, the middle or ending, declension is properly the expression of all those changes in a certain order, and by certain degrees called cases. With regard to languages, where the nouns do not admit of changes in the same number, declension is the expression of the different states a noun is in, and the different relations it has; which difference of relations is marked by particles, and called articles, as *a, the, of, to, from, by,* &c. See ARTICLE: also GRAMMAR.

DECLINATION, in astronomy, the distance of any celestial object from the equinoctial, either northward or southward. It is either true or apparent, according as the real or apparent place of the object is considered. A great circle is supposed to pass through the two poles, and through the centre of every star. This circle is called a circle of declination. The arc of this circle included between the star and the equator measures the declination of the star. The declination of a star then is its perpendicular distance from the equator. It is north or south, according as the star is situated on the north or south side of the equator. All the stars situated in the same parallel of the

equator have, of course, the same declination. The declination then marks the situation of a star north or south from the equator. Precision requires still another circle from which their distance, east or west, may be marked, in order to give the real place. The circle of declination, which passes through that point of the equator called the vernal equinoctial point, has been chosen for that purpose. The distance of the circle of declination of a given star from that point measured on the equator, or the arc of the equator included between the vernal equinox and the circle of declination of the star, is called its right ascension. If we know the declination and the right ascension of a star, we know its precise situation in the heavens.

The declination of any star may be easily found by observing the following rule: Take the meridian altitude of the star, at any place where the latitude is known; the complement of this is the zenith distance, and is called north or south as the star is north or south at the time of observation. Then, 1. When the latitude of the place and zenith distance of the star are of different kinds, namely one north and the other south, their difference will be the declination, and it is of the same kind with the latitude, when that is the greatest of the two, otherwise it is of the contrary kind.—2. If the latitude and the zenith distance are of the same kind, *i. e.* both north or both south, their sum is the declination; and it is of the same kind with the latitude. See GLOBES, *use of.*

DECLINATION *of a wall or plane for dials*, is an arch of the horizon, contained either between the plane and the prime verticle circle, if you reckon it from the east or west; or else between the meridian and the plane, if you account it from north or south. There are many ways given by authors for finding the declination of a plane, of which all those that depend upon the magnetic needle deserve to be suspected on many accounts. The common method, by finding the sun's horizontal distance from the poll of the plane, is subject to many errors and difficulties. The way therefore we would recommend as the best for finding the declination of a plane, is by a declinator.

DECLINATOR, or DECLINATORY, an instrument contrived for taking the declinations, inclinations, and reclinations of planes. See INSTRUMENTS, *mathematical.*

DECLINING *dials*, those which do not face directly any of the four cardinal points. See DIALING.

DECOCTION, the boiling of one or more ingredients in a watery fluid. See PHARMACY.

DECOMPOSITION, in chemistry. The substance resulting from a chemical combination is denominated a compound. The substances of which it is formed are called its constituent parts. When these are again separated, the process is denominated decomposition. See ANALYSIS.

DECOUPLE, in heraldry, the same as uncoupled: thus, a chevron decouplé, is a chevron wanting so much of it towards the point, that the two ends stand at a distance from one another, being parted and uncoupled.

DECOY, among fowlers, a place made for catching wild-fowl. A decoy is generally made where there is a large pond surrounded with wood, and beyond that a marshy and uncultivated country: if the piece of water is not thus surrounded, it will be attended with noises and other accidents which may be expected to frighten the wild-fowl from a quiet haunt, where they mean to sleep in the day-time in security. If these noises or disturbances are wilful, it has been held that an action will lie against the disturber. As soon as the evening sets in, the decoy rises, and the wild-fowl feed during the night. If the evening is still, the noise of their wings during their flight is heard at a very great distance, and is a pleasing, though rather melancholy sound.

The decoy ducks are fed with hemp-seed, which is thrown over the screens in small quantities, to bring them forwards into the pipes or canals, and to allure the wild-fowl to follow, as this seed is so light as to float. There are several pipes, as they are called, which lead up a narrow ditch that closes at last with a funnel-net. Over these pipes (which grow narrower from their first entrance) is a continued arch of netting suspended on hoops. It is necessary to have a pipe or ditch for almost every wind that can blow, as upon this circumstance it depends which pipe the fowl will take to; and the decoyman always keeps on the leeward side of the ducks, to prevent his scent reaching their sagacious nostrils. All along each pipe, at intervals, are placed screens made of reeds, which are so situated that it is impossible the wild-fowl should see the decoyman before they have passed on towards the end of the pipe, where the purse-net is placed. The inducement to the wild-fowl

to go up one of these pipes is, because the decoy ducks, trained to this, lead the way, either after hearing the whistle of the decoy-man, or enticed by the hemp seed; the latter will dive under water, whilst the wild-fowl fly on and are taken in the purse. It often happens, however, that the wild-fowl are in such a state of sleepiness and dozing, that they will not follow the decoy-ducks. Use is then generally made of a dog that is taught his lesson: he passes backwards and forwards between the reed screens (in which are little holes, both for the decoy-man to see, and the little dog to pass through); this attracts the eye of the wild-fowl, who, not choosing to be interrupted, advance towards the small and contemptible animal, that they may drive him away. The dog all the time, by the direction of the decoy-man, plays among the screens of reeds, nearer and nearer the purse-net; till at last, perhaps, the decoy-man appears behind a screen, and the wild-fowl not daring to pass by him in return, nor being able to escape upwards on account of the net-covering, rush on into the purse-net. Sometimes the dog will not attract their attention if a red handkerchief, or something very singular, is not put about him.

Decoy, in military affairs, a stratagem to carry off the enemy's horses in a foraging party, or from pasture. The word is also used to denote a stratagem employed by a small ship of war to betray a vessel of inferior force into an incautious pursuit till she has drawn her within the range of her cannon. It is usually performed by painting the stern and sides, in such a manner as to disguise the ship, and represent her either much smaller and of inferior force, or as a friend to the hostile vessel, which she endeavours to ensnare by assuming the emblems and ornaments of the nation to which the stranger is supposed to belong.

DECREE, in the civil law, is a determination that the emperor pronounces upon hearing a particular cause between plaintiff and defendant.

Decree is a sentence pronounced by the Lord Chancellor in the Court of Chancery, and it is equally binding upon the parties, as a judgment in a court of law. By the laws of England, a decree (notwithstanding any contempts thereof) shall not bind the goods or moveables, but only charge the person. If a decree be obtained and inrolled, so that the cause cannot be reheard, then there is no remedy but by bill of review, which must be on error appearing on the face of the decree, or on matters subsequent thereto, as a release or a receipt discovered since.

Decrees *of councils* are the laws made by them, to regulate the doctrine and policy of the church.

DECREPITATION, in chemistry, a term applied to the crackling noise of salts exposed to heat, by which they are quickly split. It takes place in those salts that have little water of crystallization, the increased temperature converting that small quantity into vapour, by which the crystals are suddenly burst. Common salt affords a good example of decrepitation, and when used as a flux should be previously decrepitated.

DECUMARIA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Myrti. Essential character: calyx eight to twelve-leaved, superior; petals eight to twelve; capsule eight-celled, with many seeds. There is but one species, *viz.* D. barbara, climbing decumaria, a native of Carolina.

DEDICATION, in matters of literature, the inscribing a book, poem, play, or the like, to some person of distinction, serving both as a protection to the piece, and a mark of the author's respect for the person to whom he dedicates his work.

DEED, is a written contract, sealed and delivered. It must be written before the sealing and delivery, otherwise it is no deed; and after it is once formally executed by the parties, nothing can be added or interlined; and therefore, if a deed be sealed and delivered with a blank left for the sum, which the obligee fills up after sealing and delivery, this will make the deed void. A deed must be made by parties capable of contracting, and upon a good consideration; and the subject matter must be legally and formally set out. The formal parts of a deed are, the premises, containing the number, names, additions, and titles of the parties. The covenants, which are clauses of agreement contained in the deed, whereby the contracting parties stipulate for the truth of certain facts, or bind themselves to the performance of some specific acts. The conclusion, which mentions the execution and date of the deed, or the time of its being given or executed, either expressly or with reference to some day and year before mentioned.

A deed is the most solemn act of law which a man can perform with respect to the disposition of his property, and there-

fore no person shall be permitted to aver or prove any thing against his own deed. All the parts of a deed indented constitute in law but one entire deed; but every part has the same operative force as all the parts taken together, and they are deemed the mutual or reciprocal acts of either of the parties, who may be bound by either part of the same, and the words of the indenture may be considered as the words of either party. If the name of baptism or surname of a party to a deed be mistaken, as John for Thomas, &c. this has been held to be dangerous. But any mistake as spelling, &c. not deviating from the substance of the deed, will not render it void. If a man get another name in common esteem than his right name, any deed made to him under such name will be valid. Every deed must be founded upon good and sufficient consideration; not upon an usurious contract, nor upon fraud or collusion, either to deceive *bona fide* purchasers, or just and lawful creditors; any of which considerations will vacate the deed, and subject the parties to forfeiture, and in some cases to imprisonment. A deed also without any consideration is void. A deed must be written upon the proper stamps prescribed by the legislature, otherwise it cannot be given in evidence.

The force and effect which the law of England gives to a deed under seal, cannot exist, unless such deed be executed by the party himself, or by another for him, in his presence, or with his direction, or in his absence, by an agent authorized so to do, by another deed also under seal, and in every such case the deed must be made and executed in the name of the principal.

A deed takes effect only from the day of delivery, and therefore if it have no date, or a date impossible, the delivery will in all cases ascertain the date of it; and if another party seal the deed, yet if the party deliver it himself, he thereby adopts the sealing and signing, and by such delivery makes them both his own. The delivery of a deed may be alleged at any time after the date, but, unless it be sealed, and regularly delivered, it is no deed. Another requisite of a deed is, that it be properly witnessed or attested; the attestation is, however, necessary, rather for preserving the evidence, than as intrinsically essential to the validity of the instrument.

There are four principles adopted by the courts of law for the exposition of deeds; *viz.* 1. That they be beneficial to the grantee or person in whose favour they are intended to operate. 2. That where the words may be employed to some interest, they shall not be void. 3. That the words be construed according to the meaning of the parties, and not otherwise; and the intent of the parties shall be carried into effect, provided such intent can possibly stand at law. 4. That they are to be consonant to the rules of law, and deeds shall be expounded reasonably without injury to the grantor, and to the greatest advantage of the grantee. Deeds are further expounded upon the whole; and if the second part contradict the first, such second part shall be void; but if the latter expound or explain the former, which it may, both parts may stand.

In construction of law, the first deed and the last will stand in force; and where a deed is by indenture between parties, none can have an action upon such deed, but the person who is a party to it. In a deed-poll, however, one person may covenant with another, who is not a party, to do certain acts; for the non-performance of which he may bring his action.

Where a man justifies title under any deed, he ought to produce that deed; if it be alleged in pleading, it must be produced to the court, that it may determine whether the deed contain sufficient words to make a valid contract.

DEER. See CERVUS.

DEFAMATION, the offence of speaking slanderous words of another; and where any person circulates any report injurious to the credit or character of another, the party injured may bring an action to recover damages proportioned to the injury he has sustained; but it is incumbent upon the party to prove that he has sustained an injury, to entitle him to damages. In some cases, however, as for words spoken which, by law, are in themselves actionable, as calling a tradesman a bankrupt, a cheat, or swindler, &c. there is no occasion to prove any particular damage, but the plaintiff must be particularly attentive to state words precisely as they were spoken, otherwise he will be nonsuited.

DEFAULT, is commonly taken for non-appearance in court at a day assigned, if a plaintiff make default in appearance in a trial at law, he will be non-suited; and where a defendant makes a default, judgment shall be had against him by default.

DEFAULT *of jurors.* If jurors made default in their appearance for trying of

Fig. 1. Cervus alces: Elk. Fig. 2. C. tarandus: rein deer. Fig. 3. C. axis: axis. Fig. 4. C. dama: fallow deer.

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causes, they shall forfeit their issues, unless they have any reasonable excuse proved by witnesses, in which case the justices may discharge the issues for default.

DEFENCE, in fortification, all sorts of works that cover and defend the opposite posts, as flanks, casemates, parapets, and faussebrays. See FORTIFICATION.

DEFENDER *of the Faith*, a peculiar title given to the King of England by Pope Leo the Tenth to King Henry the Eighth, for writing against Martin Luther, in behalf of the Church of Rome, then accounted *domicilium fidei catholicæ.*

DEFERENTIA *vasa*. See ANATOMY.

DEFICIENT *numbers*, those whose parts or multiples added together, fall short of the integer whereof they are the parts; such is 8, its parts, 1, 2, 4, making only 7. See NUMBER.

DEFILE, in fortification, a straight narrow passage, through which a company of horse or foot can pass only in file, by making a small front, so that the enemy may take an opportunity to stop their march, and to charge them with so much the more advantage, in regard that those in the front and rear, cannot reciprocally come to the relief of one another.

DEFINITE, in grammar, is applied to an article that has a precise determinate signification; such as the article *the* in English, *le* and *la* in French, &c. which fix and ascertain the noun they belong to, to some particular, as *the King*, *le Roy*; whereas in the quality *of King*, *de Roy*, the articles *of* and *de* mark nothing precise, and are therefore indefinite.

DEFINITION, the shewing the meaning of one word by several other not synonymous terms. The meaning of words being only the ideas they are made to stand for by him that uses them, the meaning of any term is then shewed, or the word is defined, when by other words, the idea it is made the sign of, and is annexed to it in the mind of the speaker, is, as it were, represented and set before the view of another; and thus its signification is ascertained. This is the only end and use of definitions, and therefore the only measure of what is, or is not a good definition.

The names then of simple ideas are incapable of being defined, because the several terms of a definition signifying several ideas, they can altogether by no means represent an idea which has no composition at all; and therefore a definition, which is properly but shewing the meaning of any one word by several others, not signifying the same each, can in the names of simple ideas have no place. Definitions which then take place in compound ideas only, are of two sorts: the definition of the name, which is the explanation of what any word means; and the definition of the things which explains in what the nature of that thing consists.

The special rules for a good definition are these: 1. A definition must be universal, or adequate, that is, it must agree to all the particular species, or individuals that are included under the same idea. 2. It must be proper, and peculiar to the thing defined, and agree to that alone. These two rules being observed, will always render a definition reciprocal with the thing defined, that is, the definition may be used in the place of the thing defined; or they may be mutually affirmed concerning each other. 3. A definition should be clear and plain; and indeed it is a general rule concerning the definition both of names and things, that no word should be used in either of them, which has any difficulty in it, unless it has been before defined. 4. A definition should be short, so that it must have no tautology in it, nor any words superfluous. 5. Neither the thing defined, nor a mere synonymous name, should make any part of the definition.

DEFLAGRATION, in chemistry, the act of burning two or more substances together, as charcoal and nitre. When a quantity of nitre, (nitrate of potash), is mixed with an equal weight of sulphur, charcoal, or other inflammable substance, if the mixture is thrown into a crucible heated to redness, a very vivid combustion is instantly excited: this is deflagration, which is thus explained: nitre is a compound of nitric acid and potash: nitric acid consists of nitrogen and oxygen; the nitre, therefore, contains a large portion of oxygen, which is in so weak a state of combination, that it is separated by exposure to a red heat. When, therefore, the mixture of the nitre, and of the inflammable body is thrown into the heated crucible, the oxygen of the former is disengaged; it is thus suddenly presented to the inflammable body, and hence the vivid combustion that is excited; and for the production of this, it is not even requisite to raise the temperature so high as that which would be necessary, if applied alone, to decompose the nitre, the affinity of the inflammable body to the oxygen of the nitre,

causing it to take place at a temperature somewhat lower. The nitrogen, or azote of the nitric acid, passes off in the state of gas, and the potash with which the acid was united, remains mixed, or united with the body formed by the combination of the oxygen, and the inflammable substance.

DEFORMITY, the want of that uniformity necessary to constitute the beauty of an object. See BEAUTY.

DEGLUTITION, in medicine, the act of swallowing the food, performed by means of the tongue driving the aliment into the œsophagus, which, by the contraction of the sphincter, protrudes the contents downwards.

DEGRADATION, a punishment of delinquent ecclesiastics. The canon-law distinguishes it into two sorts, the one summary, by word only; the other solemn, by stripping the person degraded of those ornaments and rights which are the ensigns of his order or degree.

DEGRADED *cross*, in heraldry, a cross divided into steps at each end, diminishing as they ascend towards the centre, called by the French *perronnée*.

DEGREE, in geometry, a division of a circle, including a three hundred and sixtieth part of its circumference. Every circle is supposed to be divided into three hundred and sixty parts, called degrees, and each degree divided into sixty other parts, called minutes; each of these minutes being again divided into sixty seconds, each second into thirds, and each third into fourths, and so on. By this means no more degrees or parts are reckoned in the greatest circle than in the least that is, and therefore if the same angle at the centre be subtended by two concentrical arches, as many degrees are counted in the one as in the other; for these two arches have the same proportion to their whole peripheries.

DEGREE *of latitude*. See LATITUDE.

DEGREE *of longitude*. See LONGITUDE and EARTH.

DEGREE, in universities, denotes a quality conferred on the students or members thereof, as a testimony of their proficiency in the arts or sciences, and intitling them to certain privileges. The degrees are much the same in all universities, but the laws thereof, and the previous discipline or exercise differ. The degrees are batchelor, master, and doctor, instead of which last, in some foreign universities, they have licentiate.

In each faculty there are two degrees, batchelor and doctor, which were anciently called batchelor and master. In the arts, likewise, there are two degrees which still retain the ancient denomination, *viz.* batchelor and master.

With regard to obtaining degrees at Oxford and Cambridge, matters are nearly on the same footing, only at Cambridge the discipline is somewhat more severe, and the exercises more difficult. For the degree of batchelor of arts, besides residence in the university near four years, it is required that the person in the last year have defended three questions in natural philosophy, mathematics, or ethics, and answered the objections of three several opponents at two several times; as also that he have opposed three times. After which, being examined by the master and fellows of the college, he is referred to seek his degree in the schools, where he is to sit three days, and be examined by two masters of arts appointed for the purpose. For the degree of master of arts, the candidate is obliged three several times to maintain two philosophical questions in the public schools, and to answer the objections brought against him by a master of arts. He must also keep two acts in the batchelors school, and declaim once. To pass batchelor of divinity, the candidate must have been seven years master of arts: he must have opposed a batchelor of divinity twice, kept one divinity act, and preached before the university once in Latin and once in English. For the degree of doctor, see DOCTOR.

DEGREES, in music, are the little intervals whereof the concords, or harmonical intervals are composed.

DEISTS, in the modern sense of the word, are those persons in christian countries, who acknowledging all the obligations and duties of natural religion, disbelieve the christian scheme, or revealed religion. They are so called from their belief in God alone, in opposition to Christians. The late learned Dr. Clarke, taking the denomination in the most extensive signification, distinguishes Deists into four sorts. 1. Such as pretend to believe the existence of an eternal, infinite, independent, intelligent Being, and who teach that this Supreme Being made the world, though they fancy he does not at all concern himself in the management of it. 2. Those who believe not only in the being, but also the providence of God with respect to the natural world, but who, not allowing any difference be-

tween moral good and evil, deny that God takes any notice of the morally good or evil actions of men; these things depending, as they imagine, on the arbitrary constitutions of human laws. 3. Those who having right apprehensions concerning the natural attributes of God, and his all-governing providence, and some notion of his moral perfections also; yet being prejudiced against the notion of the immortality of the human soul, believe that men perish intirely at death, and that one generation shall perpetually succeed another, without any future restoration or renovation of things. 4. Such as believe the existence of a Supreme Being, together with his providence in the government of the world, as also the obligations of natural religion; but so far only, as these things are discoverable by the light of nature alone, without believing any divine revelation. These last are the only true Deists; but as the principles of these men would naturally lead them to embrace the Christian revelation, the learned author concludes there is now no consistent scheme of deism in the world.

DELEGATES, *court of*, is so called, because the judges thereof are delegated by the King's commission under the great seal, to hear and determine appeals in the three following cases: 1. Where a sentence is given in any ecclesiastical cause by the archbishop or his official. 2. When any sentence is given in any ecclesiastical cause in the places exempt. 3. When a sentence is given in the admiral's court, in suits civil and marine, by order of the civil law. This commission is usually filled with lords spiritual and temporal, judges of the courts at Westminster, and doctors of the civil law.

DELIVERANCE, a criminal brought to trial, to which pleading not guilty, he puts himself on God and his country; the clerk of the crown wishes him a good deliverance.

DELFT *ware*, a kind of pottery of baked earth, covered with an enamel or white glazing, which gives it the appearance and neatness of porcelain. Some kinds of this enamelled pottery differ much from others, either in their sustaining sudden heat without breaking, or in the beauty and regularity of their forms, of their enamel, and of the painting with which they are ornamented. In general, the fine and beautiful enamelled potteries, which approach the nearest to porcelain in external appearance, are, at the same time, those which least resist a brisk fire. Again, those which sustain a sudden heat, are coarse, and resemble common pottery. The basis of this pottery is clay, which is to be mixed with such a quantity of sand, that the earth shall preserve enough of its ductility to be worked, moulded, and turned easily; and yet that its fatness shall be sufficiently taken from it, that it may not crack or shrink too much in drying or in baking. Vessels formed of this earth must be dried very gently to avoid cracking. They are then to be placed in a furnace to receive a slight baking, which is only meant to give them a certain consistence or hardness. And lastly, they are to be covered with an enamel or glazing, which is done by putting upon the vessels thus prepared, the enamel which has been ground very fine, and diluted with water.

As vessels on which the enamel is applied are but slightly baked, they readily imbibe the water in which the enamel is suspended, and a layer of the enamel adheres to their surface; these vessels may then be painted with colours composed of metallic calces, mixed and ground with a fusible glass. When they are become perfectly dry, they are to be placed in the furnace, included in cases of baked earth called seggars, and exposed to a heat capable of fusing uniformly the enamel which covers them. This heat given to fuse the enamel, being much stronger than that which was applied at first to give some consistence to the ware, is also the heat necessary to complete the baking of it. The furnace and colours used for painting this ware, are the same as those employed for porcelain. The glazing, which is nothing but white enamel, ought to be so opaque as not to show the ware under it. There are many receipts for making these enamels; but all of them are composed of sand or flints, vitrifying salts, oxide of lead, and oxide of tin; and the sand must be perfectly vitrified, so as to form a glass considerably fusible. Somewhat less than an equal part of alkaline salt, or twice its weight of oxide of lead, is requisite to effect such vitrifications of sand. The oxide of tin is not intended to be vitrified, but to give a white opaque colour to the mass; and one part of it is to be added to three or four parts of all the other ingredients taken together. From these general principles various enamels may be made to suit the different kinds of earths. To make the enamel,

lead and tin are oxyded together with a strong fire; and the sand is also to be made into a frit with the salt or ashes. The whole is then to be well mixed and ground together. The matter is then to be placed under the furnace, where it is melted and vitrified during the baking of the ware. It is next to be ground in a mill, and applied as above directed.

Concerning the earth of which the ware is made, pure clay is not a proper material when used alone. Different kinds of earth mixed together are found to succeed better; pieces of ware made of clay alone are found to require too much time to dry, and they crack and lose their form, unless they are made exceedingly thick; an addition of marle diminishes the contraction of the clay, renders it less compact, and allows the water to escape without altering the form of the ware in drying. It affords also a better ground for the enamel, which appears more glossy and white than when laid on clay alone. The kinds of clay which are chiefly used in the composition of delft-ware, are the blue and green. A mixture of blue clay and marle would not be sufficiently solid, and would be apt to scale, unless it were exposed to a fire more intense than what is commonly used for the burning of delft-ware. To give a greater solidity, some red clay is added; which, on account of its ferruginous matter, possesses the requisite binding quality. The proportions of these ingredients vary in different works, according to the different qualities of the earths employed. Three parts of blue clay, two parts of red clay, and five parts of marle, form the composition used in several manufactories. See ENAMEL.

DELIMA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: calyx five-leaved; corolla none; berry with two seeds. There is but one species, *viz.* D. sarmentosa, a native of Ceylon.

DELIQUESCENCE, in chemistry, a term to certain saline bodies that have become moist or liquid, by means of the water which they absorb from the atmosphere, in consequence of their great attraction to water. When the salt has, by exposure to air, become so far deliquesced as to be in a liquid state, it is said to be in the state of deliquium. Hence alkali, reduced by this means to a liquid state, was formerly denominated oil of tartar per deliquium.

DELIRIUM, in medicine, the production of ideas not answerable to external causes, from an internal indisposition of the brain, attended with a wrong judgment following from these ideas, and an affection of the mind and motion of the body accordingly: and from these increased through various degrees, either alone or joined together, various kinds of deliria are produced.

DELIVERY, *child-birth.* See MIDWIFERY.

DELPHINUM, in botany, *larkspur*, a genus of the Polyandria Trigynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary cloven, produced into a horn behind; siliques three or one. There are eleven species. These are mostly hardy annuals or perennials. The lower leaves digitate or palmate; the upper less divided, and sometimes even entire. The flowers are in loose panicles at the ends of the stem and branches, of various colours, but chiefly blue.

DELPHINUS, the *dolphin*, in natural history, a genus of Mammalia of the order Cete. Generic character: teeth in each jaw; spiracle on the head. Shaw enumerates six species, and Gmelin four. C. phocæna, or the porpesse, is the most abundant of cetaceous animals, and is found particularly in the European seas, whence it often advances very nearly to the mouths of considerable rivers. Its general length is from five to eight feet. Porpesses are gregarious, and frequently seen frolicking on the water, and playing their uncouth gambols, more especially in boisterous and tempestuous weather. They feed principally on smaller fishes, and pursue the shoals of herrings and mackrel with apparently unwearied vigour and insatiable appetite. They are covered immediately under the skin with a fatty substance of considerable thickness, and which produces a large quantity of oil. The porpesse was formerly considered, not merely as eatable, but as a species of luxury, being served up at noble and royal tables. Such, however, are the revolutions of taste, that by the least fastidious appetite this food is at present decidedly rejected.

D. delphis, or the dolphin, has the same general habits and appearance with the preceding, but is considerably longer, measuring occasionally even ten feet. It abounds both in the Pacific and European Seas, and its appearance is in general preliminary to

Fig.1. **Chætodon** *plectorhenchus: pleatnose Chætodon* *Fig.2.* **Cottus** *cataphractus: mailed Bull head* *Fig.3.* **Cyclopterus** *pavonius: Pavonian sucker* *Fig.4.* **Cyprinus** *carpio: large scaled Carp* – *Fig.5.* **Delphinus** *delphis: Dolphin.*

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a tempest. It not only pursues and attacks small fish, on which, indeed, it subsists, but assails the whale itself, and is stated to have been seen firmly adhering to whales as they have leaped from the water. The ancients appear to have had almost a superstitious attachment to this animal, and relate various anecdotes of it, implying a peculiar susceptibility of gratitude and affection, a strong attachment to mankind, and a rapturous fondness for music. In natural history, however, the ancients were more fanciful than accurate, and compared with the moderns were as dwarfs to giants. The porpesse, though naturally straight, swims in a crooked form; and the dolphin is said, by Linnæus, to be crooked only when it leaps: Shaw thinks it assumes this form also in swimming. See Pisces, Plate III. fig. 5.

D. orca, grampus. This is one of the most ravenous and formidable inhabitants of the ocean. It is found both in the Atlantic and the Mediterranean, in the northern and the southern seas, and is about 12 feet broad, and 24 in length. It preys both upon the porpesse and dolphin, as well as upon smaller fish. It frequently attacks seals, even on the uncovered rocks, dislodging and often destroying them by its dorsal fin. But it is particularly and irreconcileably hostile to whales, which it attacks without the slightest hesitation, and often fastens on with the most persevering and destructive tenacity.

DELUGE, an inundation, or overflowing of the earth, either wholly or in part, by water.

We have several deluges recorded in history, as that of Ogyges, which overflowed almost all Attica; and that of Deucalion, which drowned all Thessaly in Greece; but the most memorable was that called the universal deluge, or Noah's flood, which overflowed and destroyed the whole earth, and out of which only Noah, and those with him in the ark, escaped.

DEMAIN, or DEMESNE, signifies the king's lands appertaining to him in property. No common person hath any demains simply understood, for we have no land (that of the crown only excepted) which is not holden of a superior, for all depends either mediately, or immediately of the crown: thus, when a man in pleading would signify his land to be his own, he says that he is or was seized thereof in his demain as of fee; whereby he means, that although his land be to him and his heirs for ever, yet it is not true demain, but depending upon a superior lord, and holding by service, or rent in lieu of service, or by both service and rent.

DEMAND, calling upon a man for any sum or sums of money, or any other thing due. By the several statutes of limitation, debts, claims, &c. are to be demanded and made in time, or they will be lost by law. There are two manner of demands, the one in deed, the other in law; in deed, as in every *precepe* there is an express demand; in law, as in every entry in land, distress for rent, taking or seizing of goods, and such like acts, which may be done without any words, are demands in law.

Where there is a duty which the law makes payable on demand, no demand need be made; but if there be no duty till demand, in such case there must be a demand to make the duty.

DEMOCRACY, the same with a popular government, wherein the supreme power is lodged in the hands of the people.

The advantages of a democracy where the people at large, either collectively, or by representation, constitute the legislature, are, liberty or exemption from needless restrictions, equal laws, regulations adapted to the wants and circumstances of the people, public spirit, frugality, averseness from war, the opportunities which democratic assemblies afford to men of every description, of producing their abilities and councils to public observation, and the exciting thereby, and calling forth to the service of the commonwealth, the faculties of the best citizens. The evils attendant upon this form of government are, dissension, tumults, faction, the attempts of powerful citizens to possess themselves of empire, the confusion and clamour which are the inevitable consequences of assembling multitudes, and of propounding questions of state to the discussion of the people; the delay and disclosure of public councils and designs; and the imbecility of measures retarded by the necessity of obtaining the consent of numbers; lastly, the oppression of the provinces which are not admitted to a participation in the legislative power. The late excellent Dr. Paley mentions other advantages of a democratic constitution which, he says, ought not be forgotten: *viz.* the direction which it gives to the education, studies, and pursuits of the superior orders of the community. The share which this has in forming the public manners and national character is very important. Popular elections procure to the common people courtesy from their superiors. The

satisfaction which the people, in free governments, derive from the knowledge and agitation of political subjects; such as the proceedings and debates of the senate, the conduct and character of ministers, the revolutions, intrigues, and contention of parties; and, in general, from the discussion of public measures, questions, and occurrences. "Subjects of this sort," says the learned author of the "Principles of Moral and Political Philosophy," excite just enough of interest and emotion to afford a moderate engagement to the thoughts, without rising to any painful degree of anxiety, or ever leaving a fixed oppression upon the spirits;—and what is this but the end and aim of all those amusements which compose so much of the business of life, and of the value of riches. See GOVERNMENT, *mixed:* CONSTITUTION, &c.

DEMONSTRATION, in logic, a series of syllogisms, all whose premisses are either definitions, self-evident truths, or propositions already established.

DEMONSTRATIVE, in grammar, a term given to such pronouns as serve to indicate or point out a thing. Of this number are *hic*, *hæc*, *hoc*, among the Latins; and *this*, *that*, *these*, *those*, in English.

DEMURRAGE, is an allowance made to the master of a ship by the merchants, for being detained in port longer than the time appointed and agreed for his departure. The rate of this allowance is generally settled in the charter party. It is now firmly established that the claim of demurrage ceases, as soon as the ship is cleared out and ready for sailing.

DEMURRER, is a kind of pause or stop put to the proceeding of an action upon a point of difficulty, which must be determined by the court before any farther proceedings can be had therein.

He that demurs in law confesses the facts to be true, as stated by the opposite party; but denies that by the law arising upon those facts any injury is done to the plaintiff, or that the defendant has made out a lawful excuse. As if the matter of the plaintiff's declaration be insufficient in law, then the defendant demurs to the declaration; if, on the other hand, the defendant's excuse or plea be invalid, the plaintiff demurs in law to the plea; and so in every other part of the proceedings where either side perceives any material objection in point of law upon which he may rest his case.

General demurrer being entered, it cannot be afterwards waved without leave of the court; but a special demurrer generally may, unless the plaintiff have lost a term, or the assizes, by the defendant's demurring.

And upon either a general or special demurrer, the opposite party avers it to be sufficient, which is called a rejoinder in demurrer, and then the parties are at issue in point of law; which issue in law, or demurrer, is argued by counsel on both sides; and if the points be difficult then it is argued openly by the judges of the court, and if they, or the majority of them, concur in opinion, accordingly judgment is given: but in case of great difficulty they may adjourn into the Exchequer Chamber, where it shall be argued by all the judges.

DENARIUS, in Roman antiquity, the chief silver coin among the Romans, worth in our money about seven-pence three farthings. As a weight, it was the seventh part of a Roman ounce.

DENDRITES, or *Arborizations*. This appellation is given to figures of vegetables which are frequently observed in fossil substances. They are of two kinds; the one superficial, the other internal. The first are chiefly found on the surface of stones, and between the strata and in the fissures of those of a calcareous nature. Stones of a similar kind, when very compact, sometimes also exhibit internal arborizations; such are the marbles of Hesse, of Angersburg in Prussia, and of Baden-Dourlach on the left bank of the Rhine.

Several of these dendrites bear a striking resemblance to the poplar; while others exhibit the straight stem, pyramidal form, and pendant branches of the fir. Some specimens of dendrites found in Switzerland, represent, in a very surprising manner, plantations of willows; and many of them are so beautiful, as really to appear the work of art. The superficial dendrites are mostly of a brown, changing gradually to a reddish yellow. The internal dendrites are of a deep black. The most esteemed dendrites are those found in agates; and more particularly in the sardonyx, cornelian, and other precious stones brought from the East, and which are commonly denominated moka stones. The Oriental agates display the most varied and beautiful forms. Sometimes they exhibit the appearance of terraces covered with different species of moss, interspersed with plants of the fern-tribe, having large leaves, and the outlines exquisitely finished: the colours are likewise extremely brilliant.

DENEB, an Arabic term, signifying tail,

used by astronomers to denote several fixed stars. Thus deneb elecet signifies the bright star in the lion's tail. Deneb adigege, that in the swan's tail, &c.

DENEKIA, in botany, a genus of the Syngenesia Superflua class and order. Receptacle naked; calyx imbricate; florets of the ray two-lipped. There is but a single species, found at the Cape.

DENIZEN, a denizen is an alien born, who has obtained letters patent whereby he is constituted an English subject. A denizen is in a middle state, between an alien and a natural born or naturalized subject, partaking of the nature of both. He may take lands by purchase, or derive a title by descent through his parents or any ancestor, though they be aliens.

DENOMINATION, a name imposed on any thing, usually expressing some predominant quality. Hence, as the qualities and forms of things are either internal or external, denomination becomes, 1. Internal, which is that founded on the intrinsic form. Thus Peter is denominated learned, on account of his learning, which is something internal. 2. External denomination, that founded on an external form. Thus, a wall is said to be seen and known, from the vision and cognition employed upon it. And thus, Peter is denominated honoured by reason of honour, which is not so much in the person honoured, as in him who honours.

DENOMINATOR, in arithmetic, a term used in speaking of fractions. The denominator of a fraction is the number below the line, shewing into how many parts the integer is supposed to be divided. Thus in the fraction $\frac{3}{4}$, the number 4 shews that the integer is divided into four parts. So in the fraction $\frac{a}{b}$, b is the denominator. See FRACTION.

DENOMINATOR *of a ratio*, is the quotient arising from the division of the antecedent by the consequent. Thus 8 is the denominator of the ratio 40 : 5, because 40 divided by 5, gives 8 for a quotient. It is also called the exponent of a ratio. See EXPONENT.

DENSITY *of bodies*, is that property directly opposite to rarity, whereby they contain such a quantity of matter under such a bulk. Accordingly, a body is said to have double or triple the density of another body, when their bulk being equal, the quantity of matter is in the one double or triple the quantity of matter in the other. The densities and bulks of bodies are the two great points upon which all mechanics or laws of motion turn. It is an axiom that bodies of the same density contain equal masses under equal bulks. If the bulks of two bodies be equal, their densities are as their masses: consequently, the densities of equal bodies are as their gravities. If two bodies have the same density, their masses are as their bulks; and as their gravity is as their masses, the gravity of bodies of the same density is in the ratio of their bulk. Hence also bodies of the same density are of the same specific gravity; and bodies of different density, of different specific gravity. The quantities of matter in two bodies, are in a ratio compounded of their density and bulk: consequently their gravity is in the same ratio. If the masses or gravities of two bodies be equal, the densities are reciprocally as their bulks. The densities of any two bodies are in a ratio compounded of the direct ratio of their masses, and a reciprocal one of their bulks: consequently since the gravity of bodies is as their masses, the densities of bodies are in a ratio compounded of the direct ratio of their gravities, and a reciprocal one of their bulks.

DENSITY *of the air*, is a property that has employed the later philosophers since the discovery of the toricellian experiment. It is demonstrated, that in the same vessel, or even in vessels communicating with each other at the same distance from the centre, the air has every where the same density. The density of the air, *cæteris paribus*, increases in proportion to the compressing powers. Hence the inferior air is denser than the superior; the density, however, of the lower air, is not proportional to the weight of the atmosphere on account of heat and cold, and other causes, perhaps, which make great alterations in density and rarity. However, from the elasticity of the air, its density must be always different at different heights from the earth's surface; for the lower parts being pressed by the weight of those above, will be made to accede nearer to each other, and the more so as the weight of the incumbent air is greater. Hence, the density of the air is greatest at the earth's surface, and decreases upwards in geometrical proportion to the altitudes taken in arithmetical progression.

If the air be rendered denser, the weight of bodies in it is diminished; if rarer, increased, because bodies lose a greater part of their weight in denser than in rarer me-

diums. Hence, if the density of the air be sensibly altered, bodies equally heavy in a rarer air, if their specific gravities be considerably different, will lose their equilibrium in the denser, and the specifically heavier body will preponderate. See PNEUMATICS.

DENSITY *of planets.* The densities of bodies being proportional to their masses divided by their bulks; and, when bodies are nearly spherical, their bulks are as the cubes of their semi-diameters, of course the densities in that case are as the masses divided by the cubes of the semi-diameters. For greater exactness, we must take that semi-diameter of a planet which corresponds to the parallel, the square of the sine of which is equal to $\frac{1}{3}$, and which is equal to the third of the sum of the radius of the pole, and twice the radius of the equator. This method gives us the densities of the principal planets as follows, that of the sun being unity:

Earth	3.93933
Jupiter	0.86014
Saturn	0.49512
Herschell	1.13757

See ASTRONOMY. PLANETS, *masses of.*

DENTALIUM, *tooth-shell*, in natural history, a genus of the Vermes Testacea. Generic character: animal a terebella; shell univalve, tubular, straight or slightly curved, with the cavity open at both ends, and undivided. There are 22 species, some of which are found in the fossil state; for there are but few species in this country, and those principally of the minuter kind. D. imperforatum is found at Sandwich, but is not common. The shell is white, opaque, transversely striate, and as its specific name imports, imperforate.

DENTARIA, in botany, *English toothwort*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ. Cruciferæ, Jussieu. Essential character: silique bursting elastically with the valves rolled back; stigma emarginate; calyx converging lengthwise. There are four species, of which D. enneaphylla, nine-leaved toothwort, is about a foot and half in height; leaves biternate; leaflets lanceolate, serrate, acuminate, and smooth; flowers from three peduncles forming a panicle or raceme, erect, fasciled; calyx pale-green or yellowish; petals reddish-yellow, or yellowish-red; there is a gland on each side, between the longer stamens and the calyx, and one surrounding the base of each shorter stamen; in each cell are four seeds. It is a native of Hungary, Austria, Idria, Friuli, Silesia, in the woods. It flowers in April and May.

DENTELLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: corolla tubular five-cleft, with three toothed segments; calyx five-parted; stigmas two; capsule globular, inferior, two-celled, many-seeded. There is but one species, *viz.* D. repens, a native of New Caledonia.

DENTIFRICE, a remedy for the teeth. Various are the compositions sold for the purpose of keeping the teeth in good preservation; they are mostly composed of earthy substances, finely powdered, and mixed with alum. Acids, though very effectual for cleansing the teeth, are decidedly mischievous. Charcoal is at present in high reputation as a dentifrice; but the sepia or cuttle fish, sold by the chemists and finely powdered, and which are picked up on the sands on the southern coast, are much valued for this purpose.

DENTITION, the breeding or cutting the teeth in children. See INFANCY, *diseases of.*

DEOBSTRUENTS, in pharmacy, such medicines as open obstructions.

DEODAND, in our customs, implies a thing devoted or consecrated to God, for the pacification of his wrath, in case of any misfortune, as a person's coming to a violent end, without the fault of any reasonable creature; as if a horse should strike his keeper, and so kill him. In this case, the horse is to be deodand; that is, he is to be sold, and the price distributed to the poor, as an expiation of that dreadful event.

DEPARTURE, in navigation, is the easting or westing of a ship in respect of the meridian it departed or sailed from: or it is the difference of longitude, either east or west, between the present meridian the ship is under, and that where the last reckoning or observation was made. This departure, any where but under the equator, must be accounted according to the number of miles in a degree, proper to the parallel the ship is under.

DEPHLOGISTICATED, a term applied by Dr. Priestley, to what is now called oxygen gas, when he first discovered it. It was called by Scheele, who discovered it at the same time, vital air.

DEPOSITION. Proof in the high court

of chancery is by the depositions of witnesses; and the copies of such, regularly taken and published, are read as evidence at the hearing. For the purpose of examining witnesses in or near London, there is an examiner's office appointed: but for such as live in the country, a commission to examine witnesses is usually granted to four commissioners, two named on each side, or any three or two of them to take the depositions there. And if the witnesses reside beyond sea, a commission may be had to examine them there upon their own oaths; and, if foreigners, upon the oaths of two skilful interpreters. The commissioners are sworn to take the examinations truly and without partiality, and not to divulge them till published in the court of chancery, and their clerks are also sworn to secrecy. The witnesses are compellable by process of subpœna, as in the courts of common law, to appear and submit to examination. And when their depositions are taken, they are transmitted to the court with the same care, that the answer of a defendant is sent.

DEPOT, in military affairs, any particular place in which military stores are deposited for the use of the army. In a more extensive sense, it means several magazines collected together for that purpose. It also signifies an appropriated fort, or place, for the reception of recruits, or detached parties, belonging to different regiments.

DEPRESSION *of the pole.* When a person sails or travels towards the equator, he is said to depress the pole, because as many degrees as he approaches nearer the equator, so many degrees will the pole be nearer the horizon. This phænomenon arises from the spherical figure of the earth. When a star is under the horizon, it is termed the depression of that star under the horizon. The altitude or depression of any star is an arch of the vertical intercepted between the horizon and that star. See HORIZON and VERTICAL.

DEPRIVATION, is an ecclesiastical censure, whereby a clergyman is deprived of his parsonage, vicarage, or other spiritual promotion of dignity.

Causes of deprivation: if a clerk obtain preferment in the church by simonical contract, if he be an excommunicate, a drunkard, fornicator, adulterer, infidel, or heretic; or guilty of murder, manslaughter, perjury, forgery, &c. if a clerk be illiterate and not able to perform the duty of his church; if he be a scandalous person in life and conversation; or bastardy is objected against him; if he be under age, *viz.* the age of twenty-three years; be disobedient and incorrigible to his ordinary; or a nonconformist to the canons; if he refuse to use the common prayer; or preach in derogation of it; do not administer the sacrament, or read the articles of religion, &c.; if any parson, vicar, &c. have one benefice with cure of souls, and take plurality, without a faculty or dispensation; or if he commit waste in the houses and lands of the church called dilapidations: all these have been held good causes for deprivations of priests.

DEPTH, in geometry, the same with altitude; though, strictly speaking, we only use the term depth to denote how much one body, or part of a body, is below another.

DEPTH *of a battalion, squadron, &c.* the number of men in a file, who stand before each other in a straight line. In the ancient armies this was very great.

DEPUTATION, a mission of select persons out of a company, or body, to a prince or assembly, to treat of matters in their name. They are more or less solemn, according to the quality of those who send them, and the business they are sent upon.

DEPUTY, one who performs an office or duty in another's right: where an office is granted to a man and his heirs, he may make an assignee of that office, and consequently a deputy.

There is great difference between a deputy and assignee of an office; for an assignee hath an interest in the office itself, and does all things in his own name; for which his grantor shall not answer unless in special cases; but a deputy hath not any interest in the office, but is only the shadow of an officer, in whose name he does all things. A superior officer must answer for his deputy in civil actions, if he be not sufficient; but in criminal cases it is otherwise, where deputies are to answer for themselves.

DERIVATIVE, in grammar, a word which is derived from another called its primitive. Thus, *manhood* is derived from *man*, *deity* from *deus*, and *lawyer* from *law*.

DERMESTES, *leather-eater*, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ clavate, the club perfoliate, three of the joints thicker; thorax convex, slightly mar-

gined; head inflected, and hidden under the thorax. Gmelin has enumerated about 90 species, in three sections. A. jaw bifid. B. jaw one-toothed. C. feelers four, clavate, the last joint larger. This genus consists principally of small insects. Their larvæ are found among skins, furs, and various animal substances of a dry kind, which they injure, and on which they live. They are exceedingly destructive to books, furniture, and collections of natural history. In the grub state they are of a lengthened oval shape, and hairy, especially towards the end of the body. The complete insect has the habit of withdrawing the head beneath the thorax when handled. D. lardarius is something less than half an inch in length, and of a dusky brown colour, with the upper half of the wing-shells whitish, marked with black specks. The larva is found on dried and salted meat: and is a sad pest to museums, libraries, and preparations of natural history. D. pellio may be seen almost every where in the spring; it is less than the lardarius, and is black, with shells having each a white spot: the larva oblong, hairy, with a bristled tail.

DERRIS, in natural history, a genus of the Vermes Mollusca. Generic character: body cylindrical, composed of articulations; mouth terminal; feelers two. There is only one species. D. sanguinea, found on the coast of Pembrokeshire. Body cylindrical, gradually tapering to a point behind, composed of joints, and capable of great inflexibility, covered with a membranaceous transparent coat, through which the internal parts are visible; head extended beyond the outer skin, less than the anterior part of the body, to which it is connected by a membranaceous covering, forming a neck. It moves by an undulatory motion of the whole body.

DERVIS, a name given to all Mohammedan monks, though of various orders.

DESCENSION, in astronomy, is either right or oblique. Right descension is an arch of the equinoctial, intercepted between the next equinoctial point and the intersection of the meridian, passing through the centre of the object, at its setting, in a right sphere. Oblique descension, an arch of the equinoctial, intercepted between the next equinoctial point and the horizon, passing through the centre of the object, at its setting, in an oblique sphere.

DESCENSIONAL *difference*, that between the right and oblique descension of any heavenly body. See DESCENSION.

DESCENT, in general, is the tendency of a body from a higher to a lower place; thus all bodies, unless otherwise determined by a force superior to their gravity, descend towards the centre of the earth: the planets too may be said to descend from their aphelion to the perihelion of their orbits, as the moon does from the apogee to the perigee. Heavy bodies, meeting with no resistance, descend with an uniformly accelerated motion, for the laws of which see MECHANICS.

DESCENT, or hereditary succession, is the title of which a man on the death of his ancestor acquires his estate by right of representation, as his heir at law: and an estate so descending to the heir is in law called the inheritance.

Descent is of three kinds; by common law, by custom, or by statute. By common law, as where one hath land of inheritance in fee-simple, and dieth without disposing thereof in his life-time, and the land goes to the eldest son and heir of course, being cast upon him by the law.

Descent of fee-simple by custom, is sometimes to all the sons, or to all the brothers (where one brother dieth without issue), as in gavel-kind; sometimes to the youngest son, as in borough English; and sometimes to the eldest daughter, or the youngest, according to the customs of particular places. Descent by statute is of fee-tail, as directed by the statute of Westminster, 2. *de donis.*

DESCENT, in genealogy, the order or succession of descendants in a line or family; or their distance from a common progenitor. Thus we say, one descent, two descents, &c.

DESCENT, in heraldry, is used to express the coming down of any thing from above; as, a lion en descent, is a lion with his head towards the base points, and his heels towards one of the corners of the chief, as if he were leaping down from some high place.

DESCENT, in fortification, are the holes, vaults, and hollow places made by undermining the ground.

The descent into the moat or ditch is a deep passage made through the esplanade and covert-way, in form of a trench, whereof the upper part is covered with madriers and clays, to secure the besiegers from the enemy's fire. In wet ditches this trench is on a level with the surface of the water, but in dry ones it is sunk as deep as the bottom of the ditch.

DESCRIPTION is such a strong and beautiful representation of a thing as gives the reader a distinct view and satisfactory notion of it.

Description. In deeds and grants there must be a certain description of the lands granted, the places where they lie, and the persons to whom granted, &c. to make them good. But wills are more favoured than grants as to those descriptions; and a wrong description of the person will not make a devise void, if there be otherwise a sufficient certainty, what person was intended by the testator. Where a first description of land, &c. is false, though the second be true, a deed will be void: contra, if the first be true and the second false.

Description, applied to botany, the natural character of the whole plant, including all the external parts. In this respect the description of the species is distinguished from the specific difference, which regards the essential or striking characters only. A perfect, or complete description, is not confined to the principal parts of plants, as the root, stem, leaves, and fructification; but includes, likewise, whatever is conspicuous in their external appearance; as the foot-stalks of the leaves and flower; the stipulæ, or scales; the bracteæ, or floral leaves; the glands, or vessels of secretion; the weapons of offence and defence; the buds; the complication, or folding of the leaves within the buds; and the habit or general appearance of the whole plant. The order to be observed in the description is that of nature, proceeding from the root to the stem; next the branches; then the foot-stalks, leaves, flower-stalks, and flowers.

DESERTER, in a military sense, a soldier who, by running away from his regiment or company, abandons the service. A deserter is, by the articles of war, punishable by death, and, after conviction, is hanged at the head of the regiment he formerly belonged to, with his crime writ on his breast, and suffered to hang till the army leave that camp, for a terror to others.

DESHACHE, in heraldry, is where a beast has its limbs separated from its body, so that they still remain on the escutcheon, with only a small separation from their natural places.

DESIDERATUM, is used to signify the desirable perfections in any art or science: thus, it is a desideratum with the blacksmith, to render iron fusible by a gentle heat, and yet preserve it hard enough for ordinary uses.

DESIGN, in a general sense, the plan, order, representation, or construction, of a building, book, painting, &c.

Design, in the manufactories, expresses the figures with which the workman enriches his stuff, or silk, and which he copies after some painter, or eminent draughtsman, as in diaper, damask, and other flowered silk and tapestry, and the like.

In undertaking of such kinds of figured stuffs, it is necessary, before the first stroke of the shuttle, that the whole design be represented on the threads of the warp; we do not mean in colours, but with an infinite number of little packthreads, which, being disposed so as to raise the threads of the warp, let the workmen see, from time to time, what kind of silk is to be put in the eye of the shuttle, for woof. This method of preparing the work is called reading the design, and reading the figure, which is performed in the following manner: a paper is provided considerably broader than the stuff, and of a length proportionate to what is intended to be represented thereon.— This they divide lengthwise, by as many black lines as there are intended threads in the warp; and cross these lines, by others drawn breadthwise, which, with the former, make little equal squares: on the paper thus squared, the draughtsman designs his figures, and heightens them with colours, as he sees fit. When the design is finished, a workman reads it, while another lays it on the simblot.

To read the design, is to tell the person who manages the loom, the number of squares or threads, comprised in the space he is reading, intimating at the same time whether it is ground or figure. To put what is read on the simblot, is to fasten little strings to the several packthreads, which are to raise the threads named; and thus they continue to do till the whole design is read.

Every piece being composed of several repetitions of the same design, when the whole design is drawn, the drawer, to rebegin the design afresh, has nothing to do but to raise the little strings, with slip-knots, to the top of the simblot, which he had let down to the bottom: this he is to repeat as often as is necessary till the whole be manufactured.

The ribbon-weavers have likewise a design, but far more simple than that now described. It is drawn on paper with lines

and squares, representing the threads of the warp and woof. But instead of lines, whereof the figures of the former consist, these are constituted of points only, or dots, placed in certain of the little squares, formed by the intersection of the lines. These points mark the threads of the warp that are to be raised, and the spaces left blank denote the threads that are to keep their situation: the rest is managed as in the former.

DESIGN is also used in painting, for the first idea of a large work, drawn roughly, and in little, with an intention to be executed and finished in large. See PAINTING.

DESIGNING, the art of delineating or drawing the appearance of natural objects, by lines on a plane.

DESPOUILLE, in heraldry, the whole case, skin, or slough of a beast, with the head, feet, tail, and all appurtenances, so that being filled and stuffed, it looks like the entire creature.

DETACHMENT, in military affairs, a certain number of soldiers drawn out from several regiments or companies equally, to be employed as the general thinks proper, whether on an attack, at a siege, or in parties to secur the country.

A detachment of two or three thousand men, is a command for a brigadier; eight hundred for a colonel; four or five hundred for a lieutenant-colonel. A captain never marches on a detachment with less than fifty men, a lieutenant, an ensign, and two serjeants. A lieutenant is allowed thirty and a serjeant; and a serjeant ten or twelve men. Detachments are sometimes made of intire squadrons and battalions.

DETACHMENT, in naval affairs, is a certain number of ships of a fleet or squadron, chosen by an admiral or commodore from the others to execute some particular service.

DETENTS, in clock-work, are those stops, which, by being lifted up or let down, lock or unlock the clock in striking. See HOROLOGY.

DETENT *wheel*, or HOOP *wheel*, in a clock, that wheel which has a hoop almost round it, wherein there is a vacancy at which the clock locks.

DETERGENT. See PHARMACY.

DETERMINATE *problem*, in geometry, that which has but one, or, at least, a limited number of answers: as the following problem, which has but one only solution, *viz.* To describe an isosceles triangle on a given line, whose angles at the base shall be double that at the vertex. But the following hath two solutions, *viz.* To find an isosceles triangle, whose area and perimeter are given.

DETINUE is a writ which lies where any man comes to goods or chattels either by delivery or by finding, and refuseth to redeliver them; and it lies only for the detaining, when the detaining was lawful. In this writ the plaintiff shall recover the thing detained; and therefore it must be so certain, as that it may be specifically known. Therefore it cannot be brought for money, corn, or the like, for that cannot be known from other money or corn, unless it be in a bag or sack, for then it may be distinguishably marked.

In order therefore to ground an action of detinue, which is only for the detaining, these points are necessary: 1. That the defendant came lawfully by the goods, as either by delivery to him, or finding them. 2. That the plaintiff have a property. 3. That the goods themselves be of value. And 4. That they be ascertained in point of identity. Upon this, the jury, if they find for the plaintiff, assess the respective values of the several parcels detained, and also damages for the detension, and the judgment is conditional, that the plaintiff recover the said goods, or (if they cannot be had) their respective values, and also the damages for detaining them.

DETONATION, in chemistry, an explosion with noise, made by the inflammation of a combustible body. Decrepitation differs from denotation only as producing a fainter noise, or merely a kind of crackling sound peculiar to certain salts. Fulmination is a more quick and lively detonation, such as takes place with certain preparations of gold, silver, mercury, &c. See DECREPITATION, FULMINATION.

DETRANCHE, in heraldry, a line bendwise, proceeding always from the dexter side, but not from the very angle, diagonally athwart the shield.

DEVISE, or DEVICE, in heraldry, painting and sculpture, any emblem used to represent a certain family, person, action, or quality; with a suitable motto applied in a figurative sense.

DEVOURING, in heraldry, is when fishes are borne in an escutcheon in a feeding posture, for they swallow all the meat whole.

DEUTZIA, in botany, a genus of the Decandria Trigynia class and order. Es-

sential character: calyx one-leafed; capsule three-celled; filaments three-cusped. There is but one species, *viz.* D. scabra, a tree about the height of a man, and very much branched. It is a native of Japan, where the leaves are used by joiners in smoothing and polishing.

DEW, a dense moist vapour, falling on the earth in the form of a misling rain, while the sun is below the horizon. See METEOROLOGY; VAPOURS, *ascent of.*

DEW *worm.* See LUMBRICUS.

DEWLAP, the membranous fleshy substance that hangs down from the throats of neat cattle.

DEXTANS, in Roman antiquity, ten ounces or $\frac{10}{12}$ of their as. See As.

DEXTER, in heraldry, an appellation given to whatever belongs to the right side of a shield, or coat of arms: thus we say, bend dexter, dexter point, &c.

DEXTROCHERE, or DESTROCHERE, in heraldry, is applied to the right arm painted in a shield, sometimes naked, sometimes clothed, or adorned with a bracelet; and sometimes armed, or holding some moveable, or member used in the arms.

DIABETES, an excessive discharge of urine, which comes away crude, and exceeds the quantity of liquids drank. See MEDICINE.

DIACAUSTIC *curve,* a species of caustic curves formed by refraction. Thus if we imagine an infinite number of rays B A, BM, BD, &c. (Plate Miscel. Fig. 6.) issuing from the same luminous point B to be refracted to or from the perpendicular M C, by the given curve A M D, and so, that C E, the sines of the angles of incidence C M E, be always to C G, the sines of the refracted angles C M G, in a given ratio, then the curve H F N, which touches all the refracted rays, is called the diacaustic, or caustic by refraction.

DIACHYLON, a well known plaster, composed of a solution of litharge in olive oil: it is called emplastrum lithargyri. See PHARMACY.

DIADELPHIA, in botany, two brotherhoods; the seventeenth class in Linnæus's sexual system, consisting of plants whose flowers are hermaphrodite, and have the stamina, or male organs, united below into two sets of cylindrical filaments. See PAPILIONACEÆ.

The orders in this class are founded on the number of stamina, considered as distinct. Some pea-bloom, or butterfly-shaped flowers, have five stamina, or male organs, as monnieria; some six, as fumatory; some eight, as milk-wort; some ten, as broom, bladder-sena, lupine, lady's-finger, vetch, and the far greater number of butterfly-shaped flowers. It is only the last order that is included in the natural family papilionaceæ; the remaining four genera are distributed among other families, to which they have, at least, an equal alliance. The names given by former botanists to the extensive class of plants in question, are much more characteristic of their nature and appearance, than that of diadelphia. The figure of the flowers and fruit never varies: the latter being always of the pod-kind; the former of the butterfly shape. On the other hand, the two sets of united stamina, the only classic character expressed in the Linnæan title, are never to be traced without difficulty; for one of the sets only is properly united; the other consisting of a single filament, which, in most plants, adheres so closely to its kindred set, that it cannot be separated without the application of a pin or needle for that purpose. In some even, no separation can be effected by this means.

DIADEM, in heraldry, is applied to certain circles, or rims serving to inclose the crowns of sovereign princes, and to bear the globe and cross, or the flower de luces for their crest. The crowns of sovereigns are bound, some with a greater, and some with a less number of diadems. The bandage about the heads of moors on shields is also called diadem, in blazoning.

DIÆRESIS, in grammar, the division of one syllable into two, which is usually noted by two points over a letter, as aulaï, instead of aulæ, dissolüenda for dissolvenda.

DIAGNOSTIC, in medicine, a term given to those signs which indicate the present state of a disease, its nature and cause.

DIAGONAL, in geometry, a right line drawn across a quadrilateral figure, from one angle to an other, by some called the diameter, and by others the diameter of the figure. Thus A C, (Plate IV. Miscel. fig. 7.) is called a diagonal.

It is demonstrable, 1. That every diagonal divides a parallelogram into two equal parts. 2. That two diagonals drawn in any parallelogram bisect each other. 3. A line F G, passing through the middle point of the diagonal of a parellelogram, divides the figure into two equal parts. 4. The diagonal of a square is incommensurable with one of its sides. 5. That the sum of the squares of the two diagonals of every parellelogram is equal to the sum of the squares

of the four sides. This proposition is of great use in the theory of compound motions; for, in an oblique angled parallelogram, the greater diagonal being the subtense of an obtuse, and the lesser of an acute angle, which is the complement of the former, if the obtuse angle be conceived to grow till it be infinitely great with regard to the acute one, the great diagonal becomes the sum of the two sides, and the lesser one, nothing. Now two contiguous sides of a parallelogram being known, together with the angle they include, it is easy to find one of the diagonals in numbers, and then the foregoing proposition gives the other. This second diagonal is the line that would be described by a body impelled at the same time by two forces which should have the same ratio to each other, as the contiguous sides have, and act in those two directions; and the body would describe this diagonal in the same time, as it would have described either of the contiguous sides in, if only impelled by the force corresponding thereto. 6. In any trapezium, the sum of the squares of the four sides is equal to the sum of the squares of the two diagonals together with four times the square of the distance between the middle points of the diagonals. 7. In any trapezium, the sum of the squares of the two diagonals is double the sum of the squares of two lines bisecting the two pairs of opposite sides. 8. In any quadrilateral inscribed in a circle, the rectangle of the two diagonals is equal to the sum of the two rectangles under the two pairs of opposite sides.

DIAL. Dials are of various constructions, some being horizontal, others vertical, and others moveable, so as to apply to any particular latitude at pleasure. The use of a dial is to indicate the hour, which is done by means of a wire, or by a triangular board, &c. placed at right angles to the face or index. This triangular piece is called the stile, or gnomon, and is made to point due north: it should be perfectly vertical, and the dial's face, on which the hours are marked, should be equally divided thereby; the line of 12 being in a true direction with the stile. This line of direction is called the substile: the angle contained between the summit of the stile, and the face of the dial is called the elevation. All which have their planes, or faces parallel with the horizon, are called horizontal dials; those which have perpendicular planes, or faces, are called vertical dials; and such as are neither vertical, nor horizontal, are called reclining dials. When erect dials do not face either the north, or the south, they are called declining dials. An universal dial is one that answers for all latitudes.

The line passing under the centre of the stile longitudinally, and marking the hour of 12, is called the meridian: in declining dials the substile makes an angle with the meridian, in proportion to the deviation from a northerly direction: this angle is the difference of longitude. With respect to the manner of constructing, and of placing these useful instruments, we shall now proceed to give some account.

The following is the most simple dial that can be made. (Fig. 1. Plate Dialling.) Divide a circle into twenty-four equal parts, and draw through the several points of division, rays from the centre. That point which is to be the north, is to be marked XII., the next on the right XI., and thus as far as V., or IIII.: those on the left of the southern point 12, are to be I., II., III., &c. in regular order down to VIII. In the centre, whence the circle was drawn, fix a pin, equal in length to about a diameter of the circle, and be very careful that it be perfectly upright. Now, placing the dial at such an elevation as may equal the latitude of the place where it is to be used, see that the XIIth hour be on the meridional line. Thus for the latitude of 50, the northerly part XII. would require to be raised 50 degrees from the horizon, so that the face of the dial would stand in the plane of the equator, and cause the shadow of the pin to fall on the index, thus to point out the time of day. This is called the equinoctial dial.

The following is the best mechanical method known for making common horizontal dials. (Fig. 2.) Draw two concentric circles, between which the hours are to be marked, and assuming any point for the hour of XII., let the thickness of your gnomon, or stile, be set off by two lines *a b*, *c d* passing near the centre *e* of the circle, perfectly parallel and equidistant from the meridional line, which passes exactly through the centre, and through the midday, or XII. point. Now cross the meridional line at right angles, by the VI. o'clock line *f g*, and from the points *b* and *d*, as centres, describe the quadrants *f h*, *g i*, taking a good extent, so as to approach nearly to the hour circle for the sake of minute division; if such be required, divide the quadrants respectively into 90 equal parts; then from *d* draw a line at $11^\circ \frac{2}{3}$ from the line *c d*, which will give the place of

I. o'clock; draw another line at $24^\circ\frac{1}{2}$, which will give the place of II. o'clock; through $38^\circ\frac{1}{12}$ will give the place of III. o'clock; through $53^\circ\frac{1}{2}$ for IIII. o'clock; through $71^\circ\frac{1}{15}$ for V. o'clock; and the line crossing your meridian, will give VI. o'clock. The base of your gnomon is to be equal to a radius of the inner hour circle, having the altitude of the place you are at for its angle: thus the gnomon in this figure would have *b k*, its upper line, standing at an angle of $51^\circ\frac{1}{2}$ from its base line *a b;* the lowest part being set on to the centre of the VI. o'clock line, even with the meridional line, and the broadest (*i. e.* highest) part of the gnomon *a k*, being towards the hour of XII. The left, or morning side of the hour table is made by drawing lines, at the angles already described, from the centre *f*, through its appropriate quadrant. The hours before VI. in the morning, and after VI. in the evening, are adjusted by continuing through the centres *b* and *d*, respectively, those lines which indicate their ascertained numbers: thus the line of V., P. M., continued through the centre *d*, will give the place of V., A. M.

This dial must be placed exactly horizontal, and its XII. o'clock point, *i. e.* the meridional line, must be precisely northward. The most certain mode of laying the meridian truly north, is by observation of the polar star; or by taking an observation at XII. at noon, by means of a quadrant, when the exact moment of the sun's utmost altitude for the day being ascertained, the shadow thrown upon a plane, by means of a thin cord sustaining a heavy plumb, will give a correct northern line, either on the dial plate, already so far prepared on its base, or on any other level surface, from which a true parallel may be taken. With respect to adjusting by aid of a compass, it cannot be recommended: those instruments are often faulty, and when they are not so, the variation is not always exactly laid down.

To construct a horizontal dial by means of a terrestrial globe, elevate the pole to the latitude of the place, and bringing the nearest meridional line to the brazen meridian, set the index to XII. uppermost. Now turn the globe until the index comes exactly to I., which will be effected by a movement of 15° measured on the equator; each hour making a change of 15° on the sun's place thereon; (for 24 hours multiplied by 15, make a total of 360° equal to a whole circle.) The place where the meridional line moves to should be marked, for that will give the place of I. o'clock; move on 15° more, to find where the meridional line cuts the equator, for the place of II. o'clock; and thus in succession will all the hours' places be indicated by the meridian at each change of 15° on the horizon; always measuring close to the meridian, or following the hour hand on the index. If the latter be marked with halves and quarters of hours, the corresponding divisions may be made on the equator, as the meridian by which you are governed passes on, taking $7\frac{1}{2}^\circ$ for a half hour, and $3\frac{3}{4}^\circ$ for a quarter; but such is seldom required, except in very large dials; the eye usually judging with tolerable precision, of the quantity covered by the shade of the gnomon.

To set this off on paper, measure the number of degrees between the several parts of the meridian, noted down as stations of the governing meridional line, when passed on 15° at each movement. This being done from XII. to VI. will establish a measurement that may be imitated on any scale, observing to draw the VI. o'clock line correctly, and to give a proper length of base, as well as a due latitudinal angle to the gnomon. The method suggested by Mr. Ferguson, of filling up the interior of the horizon after drawing forth the globe, is prolix, and suits but few persons: whereas, the knowledge of how many degrees are included in each interval, respectively, proves a sufficient guide. Those intervals will be found to correspond with what have been directed in describing the 2nd figure.

To make an erect dial directly south. Fig. 3. On this the sun can shine only from VI. A.M. to VI. P.M.; therefore, only the intermediate hours need be noted. Elevate the pole as before directed, but in lieu of placing XII. to the north, place it to the south of your dial plate, which in this kind is most conveniently made an oblong, projected vertically below the VI. o'clock line. Proceed to find the places of the hours as before shewn, trace them through their centres to the opposite parts of the hour circle, for on that they are to stand. The gnomon is to make an angle equal only to the co-latitude of the place: thus, if you are in $51\frac{1}{2}^\circ$, the co-latitude (being the amount required to complete to 90°) would be $38\frac{1}{2}^\circ$.

Or you may proceed as follows: on the meridional line *a b*, as it points downwards

from the foot, or lowest part of the gnomon, measure off at pleasure any distance, as *a c*, for the size of your dial: at *c* erect the perpendicular C D, and make the angle C A D equal to the elevation of the equator; then make a second triangle C D E, the angle at D being equal to that at A. Through E draw G H at right angles with A E. Carry on E B equal to E D, and with that distance as a radius, describe the quadrant E F from B as a centre. Measure off the proper angles from the point B, through the several parts of the quadrant, which is divided off into six equal parts; these will fall upon the prolonged line G H, and give points thereon, through which lines being drawn from the centre A of the VI. o'clock line to the hour frame, the places of the several hours will be given. The gnomon is fixed at A, equal to A D E; being conformable to the co-latitude; or it may be simply a wire fixed at C, equal in length to C D, but perpendicular to the face of the dial; some use large angular iron rods. This kind of dial is often seen on the sides of country church-steeples facing the south.

To make an erect dial facing the north, invert the whole of that just described, making the gnomon point upwards instead of downwards, and causing all the lower points to be transferred from left to right, and from right to left. This kind of dial will shew the hours before VI. A. M., and after VI. P. M. When such is wanted, the best way is to set up a stout post, with the planes of two dials back to back, they pointing due south and due north, respectively; thus as the pin retires from one, it will set upon the other.

We shall now instruct the reader how to make those scales, which are indispensable towards the attainment of perfection in this pleasing branch of study.

The lines useful in dialling are, 1, a line of chords; 2, a line of latitudes; 3, a line of sines; and 4, a line of hours. They are all derived from the quadrant of a circle, as will be shewn in fig. 4.

Describe a circle and divide it into four equal parts by the lines A B and C D, intersecting in the centre E. Draw the chords A C, C B, B D. Now divide the two segments, or quadrants, A D and C B, each into nine equal parts; either of which contains 10 degrees. Placing one leg of your compasses at B for a centre, draw the several arcs from the quadrant subtended by the chord C B, so that they may fall upon that chord, which being numbered according as the several arcs correspond with the division on the quadrant, will give a line of chords gradually diminishing from B towards C: all the intermediate degrees, or the measures of 10° each, thus obtained, may be removed in the same manner from the quadrant, if it be graduated accordingly.

It will be proper to observe in this place that the chord of 60° is the radius of a circle whose quadrant is subtended by 90° of the same scale: hence a line of chords is easily made upon any circle, so that any part of that circle may be cut off at pleasure. This is essential in every branch of mathematics; but in dialling it is indispensable to be known: the reader will have observed, that in forming the horizontal dial, the hour lines are drawn through particular points, so as to make the required angles. As he may be at a loss how to effect this on many occasions, we shall give an example in fig. 5, whereby every doubt, or difficulty will be removed.

Let it be required to cut off an angle of 40 degrees from the quadrant, which appertains to a circle for which we have not a line of chords in readiness. On the base line A B measure 60 degrees from any line of chords you may have at hand: it may either exceed, or be less than your base line; we will suppose the former; in this case the base line must be prolonged to the measurement of 60° from your scale, which will carry it on to C. With that 60°, as a radius, and from A, as a centre, describe the quadrant C D, concentric with the quadrant E B, from which you would cut off 40°. Now measure 40 degrees on your line of chords, and, placing one foot of the compasses at C, carry the measurement to F, which will cause the angle F A C to measure 40°, and the line F A will, at C, cut off 40 degrees from the quadrant E B. For an angle does not vary by prolongation; therefore, if the exterior quadrant is cut at 40°, the interior quadrant, being concentric therewith, must correspond with that division.

We now proceed to the opposite quadrant, which is not subtended by a chord, but is divided into nine equal parts, of ten degrees each. Draw from the several points of division on the quadrant eight lines, all parallel with E A, and falling on the radius E D; this gives a line of sines, which is of very extensive use in various branches of mathematics. From A draw

eight lines, passing through the several points ascertained on the line of sines, to the quadrant B D: these will cut the chord subtending that quadrant, and give thereon a line of latitudes, of equal length with the line of chords, but very differently divided.

The remaining quadrant C A is to be divided into six equal parts, *viz.* of 15° each: make the chord C F A, and draw its parallel tangent G H. Through the several points of division on the quadrant, draw lines from the centre E to the line G H, which will then represent a line of hours: one of the extremes will be XII, the other will be VI; the several intermediate places of I, II, III, IV, and V, being ascertained by the various lines proceeding from E.

The 6th figure shews part of a dial, constructed by means of the lines of latitudes and of hours. Having set off the parallels for the substile, and drawn the line of VI o'clock, set off the latitude of your place from A towards B; taking the measurement from the line of latitudes. Then measure the whole extent of your line of hours, and, placing one leg of your compasses at B, let the other fall wherever it may reach on the line C A. Divide the line B C according to the measures on your line of hours; and from A draw lines through the points of division to the hour circle, which will thus be truly intersected at the horal points. We have before stated, that by dividing the quadrant C A, in fig. 4th, more minutely, that is, by dividing each of the six portions into four, the halves and quarters of hours may be shewn.

Having already shewn the modes of constructing those dials which are in ordinary use, we must refer the more curious reader to Ferguson's "Lectures," for a great variety of dials, which could not be introduced into this work without greatly augmenting the volume. He will there find the modes of constructing dials by logarithms, and by trigonometry; together with many items relating to the more abstruse parts of our subject. We shall briefly add, that the following general principle governs the formation of all dials. Take the words of that great luminary of mechanics, the late James Ferguson, F. R. S.

"If the whole earth were transparent and hollow, like a sphere of glass, and had its equator divided into 24 equal parts, by so many meridian semi-circles, one of them being the geographical meridian of any given place, say London; and if the hours of XII. were marked on the equator, both on that meridian, and on its opposite one, and all the rest of the hours on the rest of the meridians, those meridians would be the hour-circles of London: then if the sphere had an opaque axis, terminating at its poles, the shadow of that axis would fall upon every particular meridian and hour, when the sun came to the plane of the opposite meridian; and would, consequently, shew the time at London, and at all the other places on the meridian of London."

DIALECT, an appellation given to the language of a province, in so far as it differs from that of the whole kingdom. The term, however, is more particularly used in speaking of the ancient Greek, whereof there were four dialects, the Attic, Ionic, Æolic, and Doric, each of which was a perfect language in its kind, that took place in certain countries, and had peculiar beauties. In Great Britain, besides the grand diversity of English and Scotch, almost every county has a dialect of its own, all differing considerably in pronunciation, accent, and tone, although one and the same language.

DIALIUM, in botany, a genus of the Diandria Monogynia class and order. Essential character: calyx none; corolla five-petalled; stamina at the upper side of the receptacle. There is but one species, *viz.* D. indum, a tree with alternate pinnate leaves, having seven ovate oblong, acuminate, petioled, even leaflets, a hand in length. Flowers panicled, nodding. Native of the East Indies.

DIALECTICS, in the literary history of the ancients, that branch of logics which taught the rules and modes of reasoning.

DIALLING *lines*, or *scales*, are graduated lines placed on rulers, or the edge of quadrants and other instruments, to expedite the construction of dials. They are, 1. A scale of six hours, which is only a double tangent, or two lines of tangents each of 45°, set together in the middle, and equal to the whole line of sines, with the declination set against the meridian altitudes in the latitude of the place. 2. A line of latitude, which is fitted to the hour-scale, and is made by this canon. As the radius : to the chord of 90° : : so are the tangents of each respective degree of the line of latitudes : to the tangent, of other arcs. And then the natural sines of these arches are the numbers, which taken from a diagonal scale of equal parts, shall graduate the divisions of the line of latitudes to any radius. The lines of hours and latitudes

are general, for pricking down all dials with centres. See DIAL.

The other scales are particular, and give the several requisites for all upright declining dials by inspection. They are, 1. A line of chords. 2. A line for the substile's distance from the meridian. 3. A line for the stile's height. 4. A line of the angle of 12 and 6. 5. A line of inclination of meridians.

DIALOGUE, in matters of literature, a conversation between two or more persons, either by writing or by word of mouth.

DIALYSIS, in grammar, a mark or character, consisting of two points, ¨, placed over two vowels of a word, in order to separate them, because otherwise they would make a diphthong, as mosaïc, &c.

DIAMETER, in geometry, a right line passing through the centre of a circle, and terminated at each side by the circumference thereof. The chief properties of the diameter are, that it divides the circumference of a circle into two equal parts: hence we have a method of describing a semi-circle upon any line, assuming its middle point for the centre. The diameter is the greatest of all chords. For finding the ratio of the diameter to the circumference. See CIRCLE.

DIAMETER *of a conic section*, or *transverse diameter*, is a right line passing through the centre of the section, or the middle of the axis. The diameter bisects all ordinates, or lines drawn parallel to the tangent at its vertex. See CONIC SECTIONS.

DIAMETER, *conjugate*, is a diameter, in conic sections, parallel to the ordinates of another diameter, called the transverse, or parallel to the tangent at the vertex of this other.

DIAMETER, *of any curve*, is a right line which divides two other parallel right lines, in such manner that, in each of them, all the segments or ordinates on one side, between the diameter and different points of the curve, are equal to all those on the other side. This is Newton's sense of a diameter.

But, according to some, a diameter is that line, whether right or curved, which bisects all the parallels drawn from one point to another of a curve. So that in this way every curve will have a diameter; and hence the curves of the second order, have, all of them, either a right-lined diameter, or else the curves of some one of the conic sections for diameters. And many geometrical curves of the higher orders, may also have for diameters, curves of more inferior orders.

DIAMETER *of a sphere* is the diameter of the semicircle, by whose rotation the sphere is generated; in which sense it is the same with axis.

DIAMETER *of gravity*, in any surface or solid, is that line in which the center of gravity is placed. See CENTER.

DIAMETER, in astronomy. The diameters of the planets are either apparent or real: the apparent diameters are such as they appear to the eye; and being measured by a micrometer, are found different in different circumstances and parts of their orbit. See ASTRONOMY.

DIAMOND. The diamond has always been regarded as the most valuable of the gems, and, consequently, as the most valuable production of the mineral world, a superiority which it derives from its very high lustre, its transparency, and hardness. The first quality arises from its greater refractive power, which is such as to cause all the light to be reflected which falls on it at an angle of incidence greater than $24\frac{1}{2}$ degrees; and it is capable of being rendered still more brilliant by its surface being cut into facets, which multiply the reflections of light. From its hardness, too, its lustre remains uninjured: this hardness is such, that it can be cut, or rather worn down, only by rubbing one diamond against another, and is polished only by the finer diamond powder.

This substance is found in India, in the districts of Visapore and Golconda, and likewise in Bengal, and in Brazil in South America. It is not found in its original situation, but in the beds of streams, or in a loose ferruginous sand beneath the soil. The Brazilian diamonds are inferior in transparency and purity to the Oriental.

The diamond is found crystallized, being either in perfect crystals, or in fragments often encrusted with a hard coating. The usual form is an octahedron, composed of two four-sided pyramids joined by the base, the faces being somewhat convex. Of this form there are some modifications: the angles being replaced by triangular faces, so as to give rise to a dodecahedron of twenty-four faces, likewise a little convex. These are the crystallizations of the Oriental diamond. The Brazilian is generally a dodecahedron, with rhomboidal faces. These crystalline forms are often imperfect, probably from the attrition which they have

DIALLING.

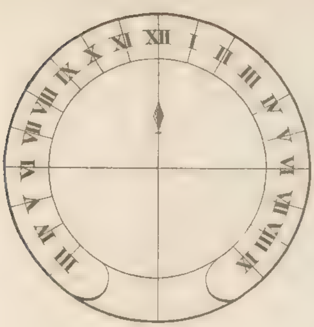


Fig. 1.

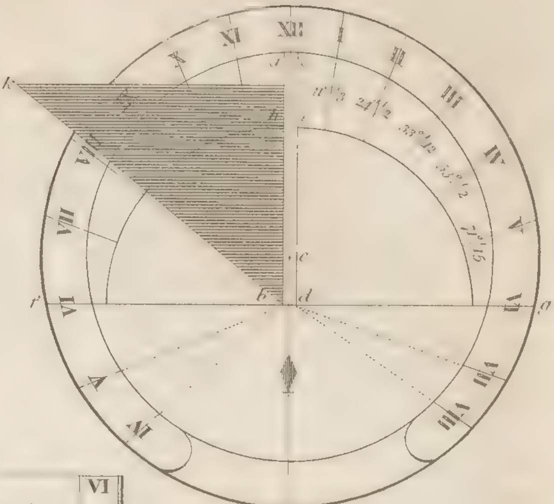
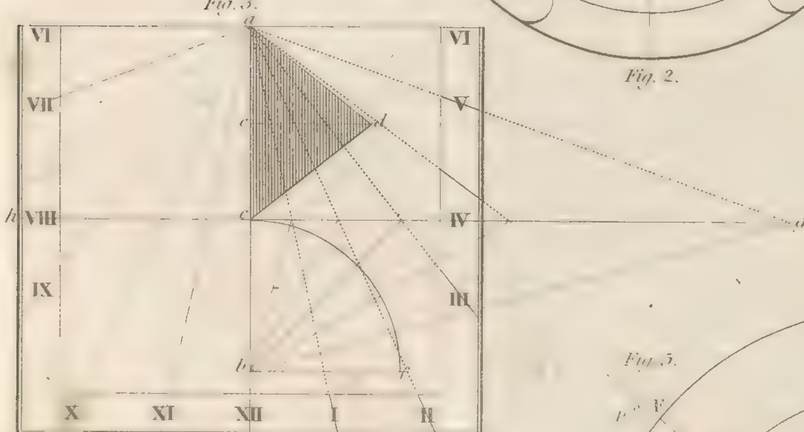


Fig. 2.

Fig. 3.



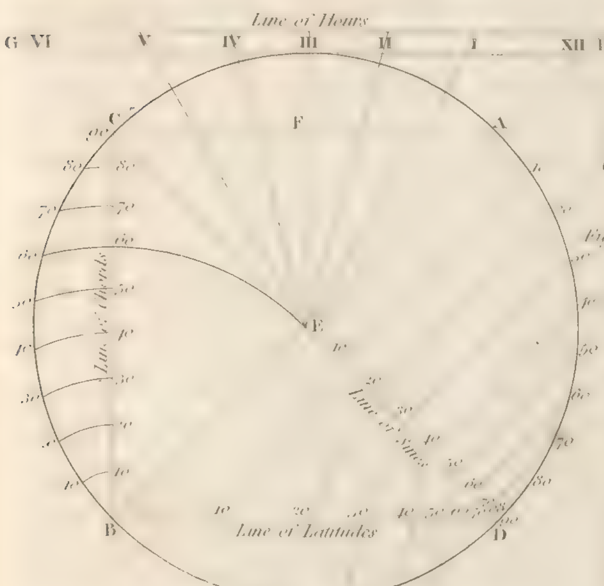


Fig. 4.

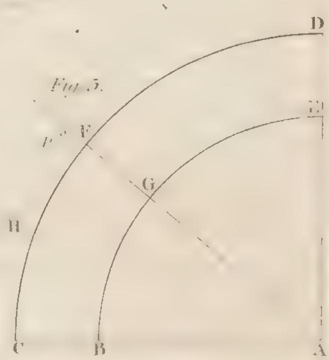


Fig. 5.

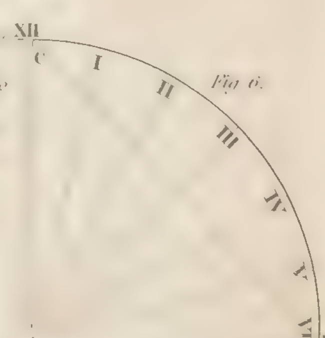


Fig. 6.

Cooper sculp

suffered, and frequently the fragments are altogether indistinct.

The diamond is colourless, or tinged of various shades of white or grey, and sometimes also, though more rarely, of brown, green, yellow, blue, and red, frequently with darker coloured spots. It is generally transparent, though not perfectly so, and has the property of single refraction; its fracture is lamellated, and it can be split by striking it in the direction of the plates. Its specific gravity is from 3500 to 3600.

The diamond is phosphorescent, or, when it has been exposed to the light, is luminous in the dark. It is rendered electrical by rubbing, the electricity being positive.

From the qualities of the diamond it was long ranked with the other gems, and considered as analogous to them in its chemical construction. Newton, by a happy application of a physical principle, conjectured that it was an inflammable substance. Transparent bodies which are uninflammable, refract light nearly in the ratio of their densities, while those which are inflammable have refractive powers which are greater than their densities; and the diamond having this great refractive power led Newton to conclude that it "probably is an unctuous substance coagulated." (Optics, Book II. Prop. 10.) In 1695 experiments had been made at Florence, which proved the diamond to be dissipated by the intense heat in the focus of the powerful burning lens of Tschirnausen. Afterward in experiments made at Vienna, it was found, that in the heat of a furnace, diamonds lost weight, and, if exposed for a sufficient length of time, entirely disappeared, while the ruby and other gems exposed to the same heat remained unaltered. At a latter period Darcet exposed diamonds to heat, enclosed in balls of porcelain clay in various ways, and always found that they were dissipated by exposure to a strong heat. These facts at the same time appeared in contradiction to the common practice of the jewellers who expose diamonds which are foul to a strong heat, imbedded in charcoal to make them clear. An observation of Macquer first threw light on this subject. He took notice, that while the diamond was exposed to a strong heat under a muffle, and while it was losing weight, it was luminous, and appeared to burn, a fact which he verified by subsequent experiments. It cannot be doubted, therefore, that in the experiments of Darcet, air had been admitted to the diamonds from rents in the porcelain clay balls, in which they were inclosed, and that in the method of jewellers they are more effectually protected from the action of the air by the charcoal dust with which they are surrounded.

Still a degree of uncertainty was attached to the subject, and to remove this, Lavoisier associating with him in the investigation, Macquer and Cadet, undertook some experiments. They first ascertained, that in close vessels the diamond does not evaporate; having exposed $19\frac{1}{8}$ grains, in a luted earthern retort, connected with a glass receiver, and the jointing secured, to a very strong heat, the loss of weight amounted only to about two grains; yet the heat applied was much higher, and continued much longer than would have been necessary to dissipate the entire quantity of diamond in the open air; and repeating the experiment of the jewellers, they found, that when carefully imbedded in charcoal powder, from which the air was excluded, the most violent heat produced no change in the diamonds submitted to trial. They were therefore disposed to conclude, that the dissipation of the diamond, when heated in the open air, was owing to its combustion. (Memoires de l'Acad. des Sciences, 1772, p. 350.) Facts similar to these were established by a second series of experiments performed by Darcet and Rouelle. And Lavoisier, in another memoir, demonstrated more decisively the combustibility of the diamond, and discovered the product of its combustion. When suddenly heated by a lens, he found it to decrepitate, and to be thrown into small fragments; when heated more slowly, it was dissipated without this decrepitation. When heated by a lens in a glass vessel placed over water, it was still dissipated, and in the first experiment no sensible product was obtained; in a second he observed, that when the heat was less powerful, the surface of the diamond became black, and was sensibly covered with a thin coating of charcoal. In a subsequent experiment, he found that the air of the vessel in which the experiment was made, was diminished in volume to the extent of about eight cubic inches in 60; on pouring into this residual air, lime water, it became milky, as it would have done from exposure to air in which charcoal had been burned; and by subjecting it to different trials, this milkiness was found to be owing to the presence of carbonic acid, which of course had been produced during the combustion of the

diamond. The same results were obtained on heating the diamond in a glass vessel containing common air placed over quicksilver. Lavoisier drew the conclusion, that the diamond is a combustible body; and that as objects of chemistry there exist a great analogy between it and charcoal.

Some years afterwards Guyton shewed that the diamond is consumed when heated with the nitrate of potassa, and affords carbonic acid. This experiment was repeated with more precision by Mr. Tenant. He exposed to a strong red heat, for an hour and a half in a gold tube, two grains and a half of small diamonds with a quarter of an ounce of nitrate of potassa. The salt was decomposed, and on examining the residuum, the potassa was found to have attracted carbonic acid, while the diamonds were entirely consumed. The quantity of carbonic acid was attempted to be ascertained, by adding to the solution of the residuum in water a solution of muriate of lime, a precipitate of carbonate of lime was formed; from this the carbonic acid was disengaged by muriatic acid, and it occupied a space equal to about 10.1 ounce measures of water. This, according to Mr. Tenant's calculation, was about the quantity that ought to have been obtained from two grains and a half of charcoal combined with oxygen; and he therefore concluded that the diamond is charcoal, and differs from that substance only in its crystallized form.

Guyton at length investigated the subject with that precision which was necessary to fix our opinion as to the nature of the diamond. The diamond, an imperfect octahedron, was placed on a small porcelain crucible, elevated in a jar filled with oxygen gas, ascertained to be pure, placed over mercury. The concentrated solar rays were thrown on the diamond by a large lens: it appeared at first farinaceous, and was afterwards sensibly blackened on its surface: the appearance of combustion was extremely faint, and when it had begun did not continue if the solar heat was withdrawn. Afterwards, when a more powerful lens was employed, the combustion was more evident; the diamond first became black, and of a coally appearance; an instant after it became brilliant, and at some points it appeared to boil; it gradually diminished, and the application of the solar heat was repeated at different times until it was entirely consumed. The quantity of carbonic acid which had been formed was ascertained by introducing a solution of barytes in water, and the unexpected result obtained, that the quantity was much greater than what would have been formed by the combustion of the same weight of charcoal as of diamond. Twenty-eight parts of charcoal in burning combine with 72 of oxygen, and from 100 of carbonic acid; while the same weight of acid, according to Guyton's experiment, is formed from the combustion of 17.88 of diamond, which combine therefore with 82.12 of oxygen. Guyton concluded, therefore, that it is not merely by its colour, weight, hardness, transparency, and other sensible qualities, that the diamond differs from charcoal; neither does the difference depend on the state of aggregation, nor are the distinctive properties of charcoal owing to the two hundredth part of residue which it leaves in the form of ashes, or to the small quantity of hydrogen which it may contain; but to its oxydation, diamond being the simple base of which charcoal is the oxide.

A striking fact with regard to the oxygenizement of the diamond is the high temperature which is requisite to its taking place. It appears from Guyton's statement, to be charred at about the temperature of 18 or 20 of Wedgwood's scale, (3417 or 3677 of Frahenheit's) and at about 30 (4977°) it burns with a feeble flame; nor does it even in oxygen gas produce as much heat as to support its own combustion. This is no doubt owing to the very strong cohesion exerted between its particles. (Memoir by Guyton, Annales de Chimie, t. 31.; or Abstract of it in Nicholson's Journal, 4to. viii. p. 298.)

The appearances attending the combustion of the diamond have been observed with perhaps more accuracy by Sir George Mackenzie; and the temperature requisite has been stated by him as less high. A diamond cut and polished, when introduced into a muffle previously heated red hot, soon acquired the same redness as the muffle, but in a few minutes more became distinguished by a bright glow, and began to consume. A piece of plumbago placed beside it exhibited a similar luminous appearance, but it began at a lower temperature. When the air was excluded from the muffle, both lost their brightness, but it returned on the admission of the air, and was much increased by blowing on them with a bellows. To ascertain at what temperature the combustion of the diamond took place, one of the pyrometrical pieces of Wedgwood was

placed with it in the muffle. When both were perfectly red throughout, the pyrometer was withdrawn, and indicated 13° of Wedgwood's scale. They were replaced, and the heat increased until the glow appeared; it was kept at this as equal as possible until the diamond was consumed; the pyrometrical piece then indicated 14°, and in another diamond the heat requisite to produce the glow, and consume it, was 15°. These experiments are evidently the most accurate that have been made to ascertain this point; and indeed the temperature assigned by Guyton were rather from conjecture than experiment. Although they shew that a less elevation of temperature is requisite for the combustion of the diamond than was supposed, they still prove it to be much higher than that which is requisite for the combustion of charcoal.

Sir George Mackenzie, likewise, repeated and confirmed an experiment of the French chemists, in which a piece of soft iron was converted into steel by being heated with diamonds, in the same manner as it would have been by being heated in the usual manner with charcoal powder; and his experiments are more satisfactory, as having been made with diamond in its purest state. (Nicholson's Journal, 4to. vol. iv. p. 103.)

The diamond is scarcely acted on by any other agent than by oxygen, at an elevated temperature. Bergman states an experiment, from which it would appear to be capable of being partially oxyded by sulphuric acid; this acid, when poured on the diamond powder, previously freed from impurities by digestion with nitro-muriatic acid, and evaporated to a small quantity, becoming black, and depositing small pellicles, which take fire on the approach of flame, and are consumed. The other acids, according to his observation, exert no sensible action on it; nor does it appear from the experiments he made with soda (the mixture of soda and of diamond powder being exposed to a very strong heat) that it had suffered any chemical change from the action of the alkali; for though a minute portion of earthly matter appeared to be produced, this might probably be derived from the various agents which were employed in the experiments. (Essays, vol. ii. p. 118.)

Diamond, in the glass trade, an instrument used for squaring the large plates or pieces; and, among glaziers, for cutting their glass.

These sorts of diamonds are differently fitted up; that used for large pieces, as looking-glasses, &c. is set in an iron ferril, about two inches long, and a quarter of an inch in diameter; the cavity of the ferril being filled up with lead, to keep the diamond firm: there is also a handle of box, or ebony, fitted to the ferril, for holding it by.

Diamond, in heraldry, a term used for expressing the black colour in the achievements of peerage. Guillim does not approve of blazoning the coats of peers by precious stones instead of metals and colours; but the English practice allows it. Morgan says the diamond is the emblem of fortitude.

DIANÆ *arbor*, or ARBOR *lunæ*, in chemistry, the beautiful crystallizations of silver, dissolved in nitrous acid, to which some quicksilver is added; and so called from their resembling the trunk, branches, leaves, &c. of a tree. This elegant arrangement, however, of the particles of silver is not peculiar to this state or menstruum, since copper filings dropped into the solution of silver in aqua fortis, is found to have the same effect, when viewed by the microscope: nay, the silver ores are frequently found ramified in the same manner.

DIANDRIA, the name of the second class in Linnæus's sexual system, consisting of hermaphrodite plants, which, as the name imports, have flowers with two stamina or male organs. The orders in this class are three, derived from the number of styles or female parts. Most plants, with two stamina, have one style, as jessamine, lilac, privet, veronica, and bastard alaternus. Vernal grass has two styles; pepper three.

DIANTHERA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Acanthi, Jussieu. Essential character: corolla ringent; capsule two-celled, bursting with an elastic nail; stamina each a pair of alternate anthers. There are twelve species, of which D. americana is a low herbaceous plant, with a perennial root, which sends out several weak stalks about four inches long. The leaves are hairy, sessile, and of a dark green colour, and an aromatic odour. The flowers are produced from the side of the stalks in small spikes, and are in shape and colour very like those of clinopodium. They come out in July, but rarely produce seeds in England. It is a native of Virginia.

DIANTHUS, in botany, a genus of the Decandria Digynia class and order. Natural order of Caryophyllei. Essential character: calyx cylindric, one-leafed, with four scales at the base; petals five, with claws; capsule cylindric, one-celled. There are thirty species. These beautiful plants are chiefly herbaceous; some few however are suffruticose. Most of them are hardy, and perennial or biennial; some of the smaller wild sorts only are annual; stalks annual, from one to three feet in height; leaves opposite, narrow, entire; flowers terminating, many aggregate, some solitary, or several together, but distinct. This numerous genus includes the sweet-williams, carnations, and pinks, with their several varieties; for a full and complete account of which we refer the reader to Martyn's edition of Millar's botany.

DIAPASON, in music, a musical interval, by which most authors who have wrote upon the theory of music, use to express the octave of the Greeks. See OCTAVE.

The diapason is the first and most perfect of the concords; if considered simply, it is but one harmonical interval, though if considered diatonically, by tones and semitones, it contains seven degrees, *viz.* the three greater tones, two lesser tones, and two greater semi-tones.

The interval of a diapason, that is the proportion of its grave sounds to its acute is duplicate, *i. e.* as 2 : 1.

DIAPENSIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Convolvuli, Jussieu. Essential character: corolla salver-shaped; calyx five-leaved, imbricate, with three other leaflets; stamens placed on the tube of the corolla; capsule three-celled. There is but one species, *viz.* D. lapponica, a native of the mountains of Lapland, among stones covered with moss, also in Norway.

DIAPERED, or DIAPRE, in heraldry, the dividing of a field in planes, like fret-work, and filling the same with variety of figures. This chiefly obtains on bordures which are diapered or fretted over, and the fret charged with things proper for bordures. Baron renders it *variatus*, which is not sufficient to express the several things of which it is variated.

DIAPHANOUS, an appellation given to all transparent bodies, or such as transmit the rays of light.

DIAPHORETICS, among physicians, all medicines which promote perspiration.

DIAPHRAGM, in anatomy, a large, robust, musculous membrane or skin, placed transversely in the trunk, and dividing the thorax from the abdomen. See ANATOMY.

DIARRHOEA, in medicine, is a frequent and copious evacuation of liquid excrement by stool. See MEDICINE.

DIASTOLE, among physicians, signifies the dilatation of the heart, auricles, and arteries; and stands opposed to the systole, or contraction of the same parts.

DIASTOLE, in grammar, a figure of prosody, whereby a syllable naturally short is made long: such is the first syllable of Priamides in the following verse of Virgil.

Atque hic Priamides: nihil ô tibi, amice, relictum.

This figure is used either out of mere poetic license, without any necessity for so doing, or through necessity, for the sake of the verse; as when three or more short syllables follow each other in hexameter verse.

DIATESSARON, among ancient musicians, a concord or harmonical interval, composed of a greater tone, a less tone, and one greater semi-tone: its proportion in numbers is as 4 : 3. The word diatessaron has been of late used by several authors for a harmony of the four gospels.

DIBBLING, in agriculture, a mode of setting corn, or other seeds, practised with advantage in places where labour is cheap; it is chiefly used for putting wheat crops into the ground. The practice of dibbling was first introduced into Norfolk, about 25 years ago. The method of dibbling is this: when the land is ploughed and rolled, a man with an iron dibble of about three feet long in each hand, walking backwards, makes two rows of holes in each furrow, at about four inches distant from each other, and an inch or two deep. The dibbler is followed by two or three women, or children, who drop two or three grains into each hole. The field is afterwards bush-harrowed. The usual quantity of seed is from a bushel and a half to two bushels per acre, and the expense of labour about ten shillings. An experienced dibbler, with three active attendants, will plant half an acre a day, making six holes in every foot length.

DICE, among gamesters, certain cubical pieces of bone or ivory, marked with dots on each of their faces, from one to six, according to the number of faces.

Sharpers have several ways of falsifying

dice: 1. By sticking a hog's bristle in them so as to make them run high or low as they please. 2. By drilling and loading them with quicksilver; which cheat is found out by holding them gently by two diagonal corners; for if false the heavy sides will turn always down. 3. By filing and rounding them. But all these ways fall far short of the art of the dice makers; some of whom are so dextrous this way that sharping gamesters will give any money for their assistance.

DICERA, in botany, a genus of the Polyandria Monogynia class and order. Essential character: petals four or five, obovate, trifid; nectary four or five emarginate corpuscles; anthers two-horned. There are two species, D. dentata, is an elegant tree, bearing at the extremities of the branches abundance of leaves, which are alternate, oval, bluntish, smooth, petioled, with a double gland at their base; flowers on very minute pedicles, nodding; stamens sixteen when there are four, and twenty when there are five petals; pistil single; fruit an oval berry, with a hard stone in it. It is preserved in its unripe state in the manner of olives. It is a native of New Zealand. D. serrata, agrees in the structure of the flower with the preceding, but differs in the fruit. This is also a native of New Zealand.

DICHONDRA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: calyx five-leaved; corolla rotate, inferior; capsule dicoccous. There is but one species, *viz.* D. repens, a native of Peru, Jamaica, and New Zealand.

DICKSONIA, in botany, so called in honour of Mr. James Dickson, a genus of the Cryptogamia Filices class and order. Natural order of Filices, or Ferns. Generic character: fructifications kidney-shaped, lying under the edge of the frond at the lower surface; outer valve formed of the substance of the leaf itself; inner membranaceous; involucre double, one from the surface, opening outwards; the other from the inflated margin of the frond, often embracing the former, opening inwards. There are thirteen species, D. arborescens, tree dicksonia, was found by Sir Joseph Banks in the island of St. Helena. It flowers most part of the winter. And D. culcita, shining-leaved dicksonia, is found in the island of Madeira, where it is called feila brom. The inhabitants make pillows and cushions of the roots. It is supposed (Phil. Trans. 1698) that this plant and the Scythian Lamb are one and the same, though they come from countries so remote.

DICOTYLEDONS, plants whose seeds have two side-lobes, and consequently rise with two seminal leaves. Most plants are of this kind. See COTYLEDONS.

In the lip and masqued flowers, the didynamia of Linnæus, and in plants whose seed-vessel is of the apple, cherry, or pod kind, the seed-leaves rise unaltered; that is, without any farther extension or developement than when they made part of the seed. In the mallow, and the cross-shaped flowers, they appear double; in buck-wheat they are rolled up; in cotton, folded or plaited; in salt-wort and all the pot-herbs, they are spiral, or twisted like a screw.

DICRANIUM, in botany, a genus of the Cryptogamia Musci class and order. Capsule ovate, oblong; fringe simple, of sixteen broadish, inflected, cloven teeth. This is a very numerous genus, divided into two sections: A. teeth of the fringe unconnected at the base; B. teeth of the fringe connected at the base.

DICTAMNUS, in botany, English *fraxinella*, a genus of the Decandria Monogynia class and order. Natural order of Multisiliquæ. Rutaceæ, Jussieu. Essential character: calyx five-leaved; petals five, patulous; filaments having glandulous dots scattered over them; capsule five, conjoined. There are two species, of which D. albus, fraxinella, has a perennial root, striking deep into the ground, and the head annually increasing in size; stalks many, two or three feet high; flowers in a long pyramidal loose spike, or raceme, nine or ten inches long; calyx deeply five-cleft; segments lanceolate, obtuse, the three upper red, the two lower green; corolla large and handsome; the natural colour pale-purple, with dark purple veins, varying to white. The whole plant, especially when gently rubbed, emits an odour like that of lemon-peel; when bruised it has something of a balsamic scent: this scent is strongest in the pedicles of the flowers, which are covered with glands of a rusty red colour, exuding a viscid juice or resin, which exhales in vapour, and in a dark place may be seen to take fire. Fraxinella is a native of Germany, France, Spain, Austria, and Italy. It flowers with us about the end of May, or early in June; the seeds ripen in September. For its beauty and fine scent it deserves a place in every good garden.

DICTIONARY, a collection, or catalogue, of all the words of a language, art, science, &c. with their explanations, ranged in alphabetical order.

DIDELPHIS, the *opossum*, in natural history, a genus of Mammalia of the order Feræ. Generic character: fore-teeth small and rounded; upper, ten small and rounded; intermediate, two, longer; lower, eight, intermediate two, broader and very short; tusks long; grinders denticulated; tongue fringed with papillæ; abdominal pouch, in most species, containing the teats.

These animals first became known to Europeans on the discovery of America, and excited their particular attention by a deviation in their structure from that of all other known quadrupeds. This singularity consisted in the female's possession of a bag or pouch in the lower part of the abdomen, which is opened and closed at pleasure, and to which her young resort for shelter and security in a variety of dangers. Some females possess, according to Gmelin, two or three of these pouches, and the male is stated also, in the same author, occasionally to have one. These animals live in the woods, burrowing in the earth, and, by means of a prehensile tail, are alert in climbing trees. Their general motion is slow, and their food consists of insects, worms and vegetables, young birds, and particularly poultry. They are by no means peculiar to the Western continent, but are to be found in various other parts of the world. According to both Shaw and Gmelin there are twenty-one species, of which the following are most deserving of attention: for the spotted opossum, see Mammalia, Plate IX. fig. 1. D. virginiana, the Virginian opossum. The size of this animal is little inferior to that of the domestic cat; its tail is covered with a scaly skin, the divisions of which give it the resemblance of a small snake, and the animal has the faculty of coiling it with great tenacity round any object, and of thus increasing its means of defence and attack, and its facility of movement among the branches of trees. The teats of the female are inclosed in that astonishing receptacle which distinguishes almost every species of this animal; and immediately after their birth, the young are introduced by their parent to that cavity, or resort to it from an impulse of their own. After first emerging from it, on attaining a certain degree of growth and vigour, they have repeated recourse to it on alarms of danger, and are securely kept, and even carried about in it by the dam till all ground of apprehension ceases. In some species this cavity does not exist, and nature has substituted for it a sort of furrow. The Virginian opossum is gentle and inoffensive in its manners, but has a rank and disagreeable smell. The female produces four or five at a birth, and prepares a sort of nest for herself, of grass, near the root of a tree. She has the power of closing her pouch, and preserving it closed so completely as to render it a matter of great difficulty to open it. D. marsupialis, the Amboyna opossum, is found in the warmer climates of South America, as well as in some countries of the East. It is bred with rabbits in India, and passes, indeed, under the name of the Aroe rabbit. It is not only considered as fit for food, but regarded as a considerable delicacy. This species is much larger than the last. D. lemurina, or the New Holland bear. The length of this animal's body is about a foot and a half, and that of its tail about a foot. It is, perhaps, the most elegant species of the genus. It has repeatedly been brought living to England. In its manners, or mode of subsistence, it resembles the other species; it is frequently perceived, however, to sit like a squirrel with its body erect, and holding its food in its hands. Its fur is extremely rich, soft, and thick. D. petaurus, or the great flying opossum of New Holland, is nearly two feet in length to the beginning of its tail, which is nearly two feet more. By an expansile membrane reaching on each side of its body, from the fore to the hind legs, it is enabled to leap to an extraordinary distance, and has thus gained the designation by which it is distinguished. Its fur is of the most exquisite fineness, and, for the greater part, of a sable or deep-grey brown colour, extremely brilliant. See Mammalia, Plate IX. fig. 2. D. sciurea, or the squirrel opossum. This and the last species are considered by Shaw as the two most beautiful quadrupeds in New South Wales. Its general appearance extremely resembles that of a squirrel. Its fur is, if possible, more soft and valuable than that of the flying opossum. Its abdominal pouch is rather beyond the usual proportion. This animal reposes by day, but during the night ranges in full activity.

DIDELTA, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compound Flowers. Corymbiferæ, Jussieu. Essential character: calyx expanding; outer-leafy; re-

ceptacle honey-combed, dividing into parts which retain the seeds; down chaffy, many-leaved. There are two species, D. carnosa, succulent-leaved didelta, has an herbaceous stem, very much branched, erect, round, nearly eighteen inches high; leaves alternate, sessile, spreading, acute, attenuated at the base, quite entire, woolly above, beneath one-nerved, veinless, two or three inches long, six or eight lines broad; in the stove permanent; flowers solitary, terminating on long peduncles, yellow; annual, but in the stove it will last some years, becoming shrubby, which is often the case with annual plants. It is a native of the Cape; also D. spinosa, where they flower about July.

DIDUS, the *dodo*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill large, and, at the middle of the upper mandible, bending inwards, marked with two oblique ribs, and considerably hooked at the tip; nostrils situated in the middle of the bill, and obliquely near the edge; legs short, thick, and in the upper part feathered; feet cleft; toes three forward and one backward; no tail. There are three species. D. ineptus, or the hooded dodo, is nearly three feet long, and inhabits the islands of Bourbon and France. Its pace is slow; its body round and fat; its weight, occasionally, fifty pounds; and though sometimes eaten, according to Herbert, is considered as indifferent food. Its head appears to be covered with a black cowl, and, altogether, its figure is singularly curious and grotesque. In Mr. Grant's history of the Mauritius, however, this bird is stated to be no longer found in that island or Bourbon; and, most probably, is to be classed among those species which have been destroyed, through the ease with which they were taken: on uninhabited islands, however, it is added, the hooded dodo may possibly yet be found. The observation of Mr. Grant, with respect to the dodo, must be supposed to apply to all those of the species, of which, indeed, the one above-mentioned is given upon much better authority than attaches to the other two. Latham thinks it not improbable that these two differed from the first only in age or sex. See Aves, Plate VI. fig. 2.

DIDYNAMIA, in botany, the name of the fourteenth class in Linnæus's method, consisting of plants with hermaphrodite flowers, which have four stamina or male organs, two of which are long, and two short.

DIETETICS, the science or philosophy of diets: that which teaches us to adapt particular foods to particular organs of digestion, or to particular states of the same organs; so that the greatest possible portion of nutriment may be extracted from a given quantity of nutritive matter; or a sufficient portion may be obtained with the least possible quantity of organic action and exhaustion. In this sense the science of dietetics embraces a knowledge as well of the organs and economy of digestion, as of the substances to be digested; and under this division we shall treat of it in the sketch before us.

The organs of digestion differ exceedingly in different classes of animals; but in all, even in zoophytes and infusory worms, there is one which answers the purpose of a stomach, the most important of all the digestive organs. In the more perfect animals, the salivary glands, the pancreas, and the liver, are all said to concur with the stomach, and, perhaps, the smaller intestines in the process of digestion; and, according to Cruikshank, about a pint of gastric, or stomach secretion, half a pint of saliva, half a pint of pancreatic juice, and twenty ounces of bile, are poured into the human stomach in the period of every twenty-four hours; while the same process is aided by a considerable quantity of solvent fluid of a different kind secreted through the whole length of the internal surfaces of the intestines. Yet as some doubts have been entertained as to the relative contributions of these different viscera; and as in different classes of animals they vary in every possible mode of deficiency, till at length, in the lowest orders, we find nothing but the stomach itself left to maintain the entire economy; more especially as we cannot at present enter into the question of the relative importance of the rest, we shall confine our observations almost exclusively to the stomach, and shall only glance at the collatitious viscera as we may perceive it absolutely necessary.

If we look back into antiquity, we shall find that the earliest opinion on the cause of digestion was, that of putridity. It was by this process that both Hippocrates and Empedocles supposed the food when taken into the stomach to be reduced to a proper state for the support of the animal system. Galen and his disciples conceived an idea that it was brought about by heat. Van Helmont, whose wild conjectures can only be accounted for by the spirit and enthu-

siasm of alchemy, which raged in his time, attributed digestion to the vital energy of the soul, which resided, as he thought, in the stomach.

Grew and Santarelli were of opinion, that the spirits which are poured forth from the nerves of the stomach, served for the concoction of the food. Boerhaave, who has in reality only attempted to reconcile the variety of opinions that had been proposed before him, supposes there are two principal agents in this vital function, *viz.* the different fluids that are collected in the stomach, and the mechanical action of that organ; the secondary agents, according to him, are heat, air, the nervous fluid, the remains of the food, and an incipient fermentation, opposing it in the extensive sense in which it was considered before him. With respect to the gastric fluid, his ideas appear to be indeterminate, and unsettled; he, however, conceived that its action on the food was merely as a simple diluent, like water, when heated to the same temperature. He had no suspicion of its being a solvent, or that it was capable of acting upon the more tenacious and hard substances that were taken in as food. According to Pringle and Macbride, digestion is carried on by a complete fermentative process. The food divided by mastication, and penetrated by the saliva, begins as soon as it enters the stomach, to be agitated by that intestine motion which always accompanies fermentation; this motion is excited by the warmth of that viscus, by the old remnants of the food, by the gastric fluid, and more particularly by the saliva, which is above all adapted to produce and promote this process. They supposed that the first effect of this intestine commotion is to raise the solid parts of the aliment to the surface of the gastric liquor, where they will be for some time sustained by the air bubbles, which, on their ceasing, must fall down again, and be thoroughly incorporated with the fluids of the stomach. This mixture is rendered still more complete by the peristaltic motion, the alternate pressure of the diaphragm and abdominal muscles, and the continual pulsation of the adjacent large vessels: in this state the food passes into the small intestines, where the fermentative motion produces still greater changes by the assistance of the bile and pancreatic juices; it is then converted into chyle. According to the opinion of Haller, the gastric juice is more or less acid in different animals; its action on the food very much resembles that of water, in which a little salt has been dissolved, which, from experience, is known to possess a very great resolvent power; and the consequence is, that an incipient fermentation takes place which reduces the aliments to a pultaceous mass. In animals that feed on seeds, this process is assisted by trituration. These, with many other fanciful opinions, took place in their turn, when Cheselden by chance happened to conjecture right, *viz.* that digestion was performed by some unknown menstruum. This conjecture was confirmed by Reaumur and Spallanzani, who have proved the menstruum to be the gastric juice, by a number of experiments, a general view of which it will be necessary to give.

Spallanzani made his experiments by introducing certain substances, such as raw vegetables, &c. enclosed in small perforated tubes, and causing animals to swallow them; he then either destroyed the animal, in order to examine it, or waited until it was vomited up. The animal kingdom may be divided into three kinds; containing stomachs muscular, intermediate, or membranous; the last class is infinitely more numerous than the two former. Of animals with muscular stomachs, such as fowls, turkeys, ducks, geese, doves, pigeons, &c. the food is seeds, such as wheat, barley, pease, &c.; when it is taken spontaneously by these birds, it remains sometime in the craw, where it is macerated and becomes softer; it is then conveyed into the stomach or gizzard, which is composed of very strong muscles, capable of grinding not only the grain it receives, but is of such force as even to reduce small pieces of glass, and blunt the points of needles: by this means the food is triturated and reduced very small; it is then converted, by the gastric juice it meets with in this viscus, into a pultaceous mass called chyme. Spallanzani found, that the gastric juice of this class digests flesh, and that the animals are for the most part both frugivorous and granivorous. He found it dissolved raw flesh, when bruised, in about two days; but when entire, four and sometimes five days were necessary: it dissolves grain only when bruised; hence, in the gallinaceous class, trituration and the gastric fluid in the gizzard, although Reaumur was of opinion it contained no menstruum, mutually assist each other; the former by breaking down the aliments in a mechanical way, prepares it for the latter, which penetrates it, de-

stroys its texture, dissolves its particles, and disposes them to change their nature and become animalized. Spallanzani thinks, that this gastric fluid traced in the gizzard, proceeds chiefly from the œsophagus; the chyme he found to be a semifluid pultaceous mass, of a whitish yellow colour: the transparency of this gastric juice, in a state of purity, is little inferior to water; it is fluid, and a little bitterish and saline; it retains, out of the body, when warm, the power of dissolving animal and vegetable substances; but it must be fresh, for if kept in vessels, particularly if open, it loses its efficacy; it must not have been used for experiments, and likewise a heat, equal to that of the bird, is necessary, otherwise it has no more effect than water.

The ruminating animals of the third class, such as sheep, oxen, &c. very much resemble this class of birds in their manner of digesting substances; in both, the gastric fluid requires an agent capable of breaking down the food, before it can dissolve it. The hay and grass, in the ruminating tribe, descend immediately into the first and second stomachs, in nearly the same state as when first brouzed: here they are softened by the juices, as seeds are in the craws of birds with gizzards; but as the stomachs of these quadrupeds have no triturating power, and the aliment requires trituration, it ascends, in consequence of a gentle stimulus to vomit, into the cavity of the mouth, where, by means of rumination, it is put into the same state previous to being digested by the gastric fluid, as happens to the food in the stomachs of granivorous fowls, after they have been properly triturated by the gastric muscles.

Animals with intermediate stomachs, such as ravens, crows, herons, &c. have muscular stomachs, which are by no means equal in force to the stomachs of the first class, but much more so than those of the third class. These animals possess the privilege of returning substances they are incapable of digesting, at least every nine, and in general every two or three hours; they are omnivorous. Their gastric juice does not dissolve whole seeds, they therefore bruise them with their beak and feet, and they are dissolved in twenty-four hours; it soon dissolves flesh and cartilage, but not bone. The fluid in the œsophagus, Spallanzani found inconsiderable as a menstruum, when compared with that of the stomach, since the first was six hours in dissolving two parts of flesh, and the second one hour only in dissolving six parts; consequently the œsophagal liquor in the craws of the gallinaceous, is different from that in this class. The resemblances between the gastric fluids of these two classes may be reduced to five: 1st, These fluids, besides being alike in colour, are always salt and bitter, which bitterness proceeds from the bile regurgitating through the pylorus into the stomach. 2dly, They are the immediate agents of digestion, both in the muscular and intermediate stomachs, independently of trituration. 3dly, The fluids act in the stomachs of these two classes of birds in the same manner, in the solution of the food; they first soften, and next convert the surface into a jelly, then produce the same effect on the intermediate parts, insinuating themselves gradually into its substance until it is completely dissolved. 4thly, They do not entirely lose their solvent power as soon as taken out of the stomach, provided they be heated to a proper degree. 5thly, The origins whence these fluids spring are nearly the same, *viz.* the follicular glands with which their organs abound. With respect to the differences, they are in part reducible to the inferior efficacy of the gastric fluid in muscular, to that of the same fluid in intermediate stomachs. The gastric juice of the first is incapable of dissolving the same aliment that the latter readily dissolves; likewise, the food which each kind of gastric juice decomposes and digests, is sooner subject to this change from that which belongs to intermediate stomachs: hence, artificial digestion succeeds much sooner with the first than the second. The same inefficacy that the gastric juices of birds with muscular stomachs shows in the solution of aliments of a firm texture, extends also to their œsophagal juices in the solution of soft substances; notwithstanding the latter are tolerably well decomposed by the œsophagal juice of birds with intermediate stomachs. Another very striking difference is, the prodigious force of trituration in muscular stomachs, and the weakness of the other, which greatness of strength was necessary in birds whose foo l is of considerable firmness, as seeds.

Animals with *membranous* stomachs, such as frogs, newts, snakes, fishes, ruminating animals; carnivorous birds and beasts, as the eagle, falcon, man, dog, cat, &c. this class is infinitely more numerous than the two former; it comprehends nearly all the quadrupeds, fishes, reptiles, birds of prey, and the greater part of insects.

From Spallanzani's experiments it appears, that carnivorous birds do not dissolve

vegetables, and throw up the indigestible part every twenty-four hours; that nature in these animals, whose digestion depends on the gastric juice alone, without any previous mastication or trituration, has provided them with a much larger quantity of it than the other classes; that digestion is in proportion to the quantity of this fluid; that the gastric juice of the ruminating class has no effect in dissolving plants, unless they have been previously macerated, and ground by the teeth; that its colour in sheep is green, and yellow in cows; that owls digest flesh and bones, but not grain; that their gastric juice evaporates sooner than water; that, that of the eagle dissolves bread and bone; its colour is cineritious, and it digests animal and vegetable matters out of the body; that a wood-pigeon may be brought by degrees to live on flesh; that the owl and falcon do not digest bread; that the gastric juice of the dog dissolves the enamel of the teeth; and that trituration is necessary in the ruminating order, and man, which is produced by the teeth, as in gallinaceous fowls by the gizzard; but in other animals, as in the frog, newt, serpents, and birds of prey, trituration does not contribute to digestion: hence, in every order of animals, the gastric juice is the principal cause of digestion, and it agrees in every class in many properties, and differs in others. In the frog, the newt, scaly fishes, and other cold animals, it produces digestion in a temperature nearly equal to that of the atmosphere. In warm animals it is incapable of dissolving the aliment in a degree of heat lower than that of these animals. In warm animals the food is digested in a few hours, whereas in the opposite kind it requires several days, and even weeks, particularly in serpents; likewise, the gastric juice of the gallinaceous class can only dissolve bodies of a soft and yielding texture, and previously triturated; whilst in others, as serpents, the heron, birds of prey, and the dog, it decomposes substances of great tenacity, as ligaments and tendons; and even of considerable hardness, as the most compact bone: man belongs to this class, but his gastric juice seems to have no action on the hardest kind of bones. Some species likewise are incapable of digesting vegetables, as birds of prey; but man, the dog, cat, crows, &c. dissolve the individuals of both kingdoms alike, and are omnivorous, and in general their gastric juices produce these effects out of the body: hence, the dissolving power of this fluid depends on the difference of the nourishment, and by some authors it has been said to be the cause of hunger and of the difference in the choice of the particular aliment; by which power the carnivorous only enjoy flesh; the granivorous and ruminating, only vegetable aliments, and no flesh; but man and the omnivorous, both vegetable and animal substances. It is, however, asserted by Carradori, as decided, that nocturnal birds of prey are capable of digesting vegetables: it results from his experiments, that they also support themselves very well with this nourishment, in spite of their repugnance to it. If this be the case, the opinion is erroneous, that the gastric juice of these birds has only an affinity with animal substances; and what he has established, *viz.* that carnivorous animals find a nutriment in the products of plants, was already rendered probable by the discovery of Fourcroy, of the existence of gluten, albumen, and gelatin in the vegetable tribes. Spallanzani, however, proves the insufficiency of Carradori's experiments, as the owl died when confined to vegetable food. The time, moreover, requisite for digestion is different in different animals; in many it does not exceed five or six hours, and in some it is much shorter.

From the numerous experiments of Gosse of Geneva upon digestion, and the action which the gastric juice has upon different substances, great light has been afforded us upon this interesting subject. He informs us, that in about one hour and a half after the food is taken into the stomach, it is changed into a pultaceous mass; the gastric juice, likewise, renders it fluid without altering its nature; and when digestion is properly carried on there is no appearance of acidity or alkalescence; the food does not ferment, and the process of digestion is not completed until the space of between two and three hours has elapsed. The chyme which arises from aliments taken either from the animal or vegetable kingdom is the same; they both are by the gastric fluid converted into the same substance, which is in consequence, most probably, of their both containing gelatin, &c.: if, however, the digesting solvent is not in sufficient quantity, or is in a diseased state, the acetous fermentation will take place in vegetable, and the putrid in animal matter; hence milk, vegetable matter containing sugar, wine, and even spirits, will degenerate, when left to their spontaneous changes in the stomach, to a very strong acid, and sooner, sometimes, than out of the body, perhaps from the heat, &c.; all oily sub-

stances likewise become rancid, and flesh meat putrid, producing acid and putrid eructations, which is never the case in a state of healthy digestion; whilst, in many animals, the digestion is finished before the acetous or putrid fermentation can begin.

Substances insoluble, or that were not digested in the usual time in the stomach. Animal substances: 1. Tendinous parts. 2. Bones. 3. Oily or fatty parts. 4. Indurated white of egg. Vegetable substances. 1. Oily or emulsive seeds. 2. Expressed oils of different nuts and kernels. 3. Dried grapes, and the skins of fish. 4. Rind of farinaceous substances. 5. Pods of beans and pease. 6. Skins of stone fruits. 7. Husks of fruits with grains or seeds. 8. Capsules of fruit with grains. 9. Ligneous stones of fruits. 10. The gastric juice does not destroy the life of some seeds, hence bittersweet, hemp, misletoe, and other plants which sometimes grow upon trees, are produced by the means of the excrements of birds, the kernels of the seeds being defended from the menstruum by exterior covering. Substances partly soluble, or parts of which were digested. Animal substances: 1. Pork dressed various ways. 2. Black puddings. 3. Fritters of eggs, fried eggs and bacon, vegetable substances. 1. Salads of different kinds rendered more so when dressed. 2. White of cabbage, less soluble than red. 3. Beet, cardoons, onions, and leeks. 4. Roots of scurvy grass, red and yellow carrots, succory, are more insoluble in the form of salad than any other way. 5. The pulp of fruit with seeds, when not fluid. 6. Warm bread and sweet pastry, from their producing acidity. 7. Fresh and dry figs. By frying all the substances in butter or oil they become still less soluble. If they are not dissolved in the stomach, they are, however, in the course of their passage through the intestines. Substances soluble or easy of digestion, and which are reduced to a pulp in an hour, or an hour and a half. Animal substances: 1. Veal, lamb, and in general the flesh of young animals, are sooner dissolved than that of old. 2. Fresh eggs. 3. Cows' milk. 4. Perch boiled with a little salt and parsley; when fried or seasoned with oil, wine, and white sauce, it is not so soluble. Vegetable substances: 1. Herbs, as spinach mixed with sorrel, are less soluble; celery, tops of asparagus, hops, and the ornithogalus of the Pyrenees. 2. Bottom of artichokes. 3. Boiled pulp of fruits, seasoned with sugar. 4. Pulp or meal of farinaceous seeds. 5. Different sorts of wheaten bread, without butter, the second day after baking, the crust more so than the crumb, salted bread of Geneva more so than that of Paris, without salt; brown bread in proportion as it contains more bran is less soluble. 6. Rapes, turnips, potatoes, parsnips not too old. 7. Gum arabic; but its acid is soon felt: the Arabians use it as food. Substances which facilitate the menstrual power of the gastric juice are sea-salt, spices, mustard, scurvy grass, horse radish, radish, capers, wine, spirits in small quantities, cheese, particularly when old, sugar, various bitters. Substances which retard the gastric power, are water particularly hot, and taken in large quantities. It occasions the food to pass into the intestines without being properly dissolved. All acids, astringents, 24 grains of Peruvian bark, taken half an hour after dinner, stop digestion. All unctuous substances, kermes, corrosive sublimate.

Gosse likewise observed, that employment after a meal suspended or retarded digestion, as well as leaning with the breast against a table; and that repose of mind, vertical position, and gentle exercise facilitated it. It likewise appears, that from the soluble power of this fluid, digestion goes on after death, but it is far less considerable than in the living animal; that in fishes it retains its property of digesting flesh, but in an inferior degree to that of birds; and that in some animals heat is necessary to this power which acts independent of the vital power.

Hunter attributes to the action of the gastric juice, the erosions found in the stomachs of those who have died suddenly, in which sometimes the great curvature of that organ is entirely consumed; he often found them on opening dead bodies; the edges of the wounds appearing like half-digested food.

Such is the stupendous power of that fluid which is perpetually secreting by the stomach in a state of health, in order to communicate and dissolve into a pultaceous mass the alimentary substances which are introduced into it. Here, however, the action of the gastric juice, and perhaps of the stomach itself, ceases: for whatever is found in the stomach is chyme, or this pultaceous and uniform mass alone. We have no chyle, except by regurgitation from the smaller intestines. The stomach is therefore altogether a preparatory organ, and it appears to be the action of the different fluids secreted from the collatitious viscera,

the saliva, the pancreatic juice, and the bile, (we confine ourselves to the more perfect animals) that are alone able to convert this comminutest chyme into the saccharine fluid, called chyle as it descends through the pylorus, or inferior orifice of the stomach, into the duodenum, in which the process of chylification is chiefly performed, and amidst the folds or *valvulæ conniventes* of which, the lacteals are most numerously seated.

Yet it is not every thing the stomach is capable of dissolving that the secondary action of the chylopoïetic viscera is capable of converting into food, or of converting with equal facility; nor is it every substance, as we have already seen, containing the real principle of aliment, that the stomach itself is capable of dissolving in the same period of time, or with the same degree of ease.

Hence the necessity of attending to what we have made the second branch in our present tract on dietetics, the nature of different alimentary substances, and especially of the common principle on which the aliment of all of them may perhaps depend.

Regarding this subject on a comprehensive scale, we have much reason to suppose that there is no substance whatever, either in animal, vegetable, or mineral existence, but contains a basis from which some animal or other is capable of extracting nutriment. Nor is this much to be wondered at, since we have already observed, that in different classes of animals the organs of digestion vary in every possible manner in regard to their presence or deficiency; and more especially since we know that the fluid secreted by the stomach itself, the only organ that is universal, is equally discrepant in its powers and qualities in animals of different structure; being in some naturally acid, in others alkaline, and in others again insipid or neutral. And hence we not only discern the truth, but can trace the real cause of the fact long ago observed by Lucretius, iv. 640.

Tantaque in hiis rebus distantia, differitusque est,
Ut, quod aliis cibus est, aliis fuat acre venerum.

"——— So vast, at times,
The strange discordance, that which poisons this,
To that proves healthful and prolongates life."

GOOD.

We can hence see the reason why many of the serpent tribe should convert a wholesome nutriment into a venemous secretion; why the euphorbia, or spurge, so noxious to man, and most quadrupeds, should be greedily devoured by several of the insect tribes; why the cicuta, which proves poison to the human race and the horse, should be luxuriously feasted upon by goats and quails; while the horse, on the contrary, feeds with pleasure on the aconite, or bane-berry, which the goat will not touch.

A thousand such peculiarities might be advanced if it were necessary; but these alone are sufficient to prove that every created substance possesses the basis of a nutriment for some order of animals or other; and that all that seems necessary, with respect to those generally esteemed the most poisonous, is a peculiar power in the stomach to select the parts that are nutritious from those that are baneful, and to secrete these alone into the system.

These observations apply to food generally. We now proceed to observe, that even the same foods, under certain states of the stomach, to which they are naturally appropriate, will not universally produce the same beneficial results. Two questions, hence, naturally arise. What are those states of the stomach in which its appropriate foods have for the most part a tendency to prove injurious instead of salutary (for the digestion of every aliment must do either the one or the other)? And of what nature are those substances which, under almost every circumstance form an exception to the rule of disease, and may still be swallowed with benefit?

It is clear then, in the first place, that the states of the stomach here referred to, are morbid states: morbid either from idiopathic, or symptomatic affection: and, secondly that, as in all such cases, the common action of the stomach must be debilitated, and consequently its secreted or gastric juice partake of the debility, or be extruded in a much weaker and more dilute state, those aliments only can be usefully employed, which are both capable of being digested with a small portion of gastric energy, and at the same time capable, when digested, of affording a very large portion of the nutritive principle.

It also happens, and that not unfrequently, that in the preparation of such foods, we can add such accessary qualities as may tend to oppose the morbid affection of the stomach, or the temperament generally, and

thus acquire a double advantage, by imprinting upon our aliment a medicinal character; as when in flatulencies, we make spices a part of the regimen recommended; in scorbutic affections, acids; and in acidities, animal oils. But such accessaries are rather medicines themselves than foods, and have scarcely a right to be regarded otherwise.

What then are those states of the stomach, either original, or dependent, which render it necessary to deviate from the general licence of nature, and to restrict those who are thus morbidly affected, to medicinal diets or regimens?

To catalogue and treat individually of the whole of these would require the space of a quarto volume: we must confine ourselves therefore to the chief of such affections, and, in discussing these few, endeavour to make our rules so comprehensive as to be a general directory to the rest.

The principle diseases then, whether local or constitutional, in which the human stomach becomes so affected as to render it a proper subject of medicinal diet, are acidity, flatulency, heart-burn; impletion; chronical sick-head-ach and hypochondriasis; hepatic affection from hot climates; hepatic affection from hard drinking.

OF ACIDITY *and its concomitants or effects.*

It is difficult to determine whether acidity of the stomach depend at all times on the introduction of acid by the mouth; or whether the gastric fluid be sometimes secreted in a vitiated state. A great variety of acids are occasionally introduced into the human stomach with food or medicine; and that acid, which is the product of fermentation, is frequently formed in the stomach from the spontaneous changes of vegetable matter in cases of imperfect digestion, and where food is taken in so large quantity that it is impossible for any stomach to dissolve it: from the latter cause principally, the acid so perpetually troublesome to the stomachs of children appears to arise; and the cardialgia of adults may justly be supposed most frequently to have the same origin: it is constantly to be observed, however, that in obstructions of the liver or gall-ducts, symptoms of cardialgia occur, and that in cases of sick head-ach and of hypochondriasis, where the strictest attention has been paid to rules of diet, the patient is not relieved till acid be evacuated from the stomach either by vomiting or purging: hence it appears probable that the gastric fluid is in itself vitiated in some diseases, having acquired the properties of an irritating acid, and being bereft of its solvent power; and that a due secretion of the bile is always requisite to the correction of acid in the stomach, both as neutralizing the acid matter, and as stimulating the intestines to expel any uncombined acid which may resist its effects, or prove more than it is adequate to neutralize.

The symptoms attending acidity in the stomach are flatulency; cardialgia; nausea; vomiting; costiveness, or purging with discoloured fæces; foul bowels; head-ach; paleness, sometimes alternating with flushing; increased pulse; a tongue coated with a white or brownish fur; increased heat, particularly on the skin of the abdomen; loss of appetite; sense of weight, pain, and oppression; rigors; langour, particularly about the eyes, with discoloration round the eye-lids; stupor, and convulsions, or a dilated pupil so as to resemble hydrocephalus. These symptoms occur according to the magnitude and duration of the attack, in conjunction with the constitution of the patient.

In all common acidities in the stomach, evacuation from the bowels is always necessary, whether the attack be accompanied with costiveness, or purgation. For this purpose calomel is generally highly serviceable. From its nature, and the smallness of the quantity requisite to produce the requisite effect, it may be taken without being tasted, and it commonly produces no nausea or vomiting, when a fluid purgative would instantly have this effect, from its irritation on the already irritated stomach, and from the sympathy of that viscus with the organs of taste and smell when offended by such medicine: the mode of operation of calomel, and its quickness of action, also highly contribute to render it eminently useful; it instantly excites copious mucous secretion from the glands of the stomach, which contributes to dilute and wash away the offending acid, and a considerable portion of this medicine quickly passing the pylorus augments the secretion of bile, the natural corrector of acid; and that of the pancreas, producing further dilution. It may be given in doses from one grain to five, or even in larger quantity, according to the age and strength of the patient, and repeated as occasion may require. In an hour or two after its exhibition, the stomach will bear some di-

rectly purgative matter, which should be given to insure the passage of the calomel through the bowels, and to increase the purgative effect. Rhubarb will hereafter be of great advantage intermixed with some aromatic powder or pungent water, as mint or peppermint; though the neutral salts will better agree with some constitutions. Absorbents we cannot recommend so largely as they have often been recommended, especially the calcareous earths, for it often happens that the insoluble compound formed by the union of chalk and the acid in the stomach increases the load and irritation in the bowels. In slight, or recent cases, they are chiefly useful, and to be depended upon.

The morbid matter being removed or destroyed, strict attention to diet is next of very considerable consequence. Whatever is light and easy of digestion, and especially whatever at the same time contains in itself a considerable portion of the nutritive principle, and counteracts acescency, is the bill of fare to be rigidly adhered to. If there be thirst, barley water may be taken plentifully; rice gruel is preferable to decoctions of oatmeal, as being less ready to ferment, and containing more demulient mucilage. As more solid food rice itself may be habitually resorted to with light animal food of any kind, and varied in whatever way the patient may prefer. Cardialgia, or heart-burn, flatulence, and hence tympanites, or enlargement of the belly, are often mere symptoms dependent upon that debilitated state of the stomach, that predisposes it to a morbid secretion, or renders it ineffectual to digest the common aliments that are introduced to it, or even to resist the acetous fermentation to which they are too often inclined. Whatever, therefore, of medicine or regimen will tend to remove this state of the stomach, will tend at the same time to destroy these distressing symptoms which are but its concomitants or dependants. Worms, again, may be regarded as another result of the same debilitated action; for, whether in children or adults, they will never be found to exist either in the stomach or intestines, while these are in a state of perfect health, and thoroughly competent to a secretion of their appropriate fluids. These, however, like the acidity of the stomach, must first be discharged from their station before we can expect any great degree of benefit from an habitual regimen.

To the diet already recommended, we may then add gentle tonics and cordials, especially wine and palatable spices. Soda water will also generally be a beverage of very essential advantage, both from the carbonic acid gass and from the alkali it contains, the one proving gently tonic to the stomach, and the other correcting the superabundant acid: and it is commonly necessary to continue the use of rhubarb, or some other purgative with alkaline and slight bitter medicines for a length of time, where the complaint shews a disposition to return.

IMPLETION OF THE STOMACH.

This disease is of two kinds: the one from temporary satiety, which is easily removed by emetics and purgatives; but which from not being removed in due time, not unfrequently produces stupor and apoplexy. The other, and which chiefly belongs to our present consideration, from habitual abstinence, from exercise, accompanied with an habitual proclination of the body, as occurs in the trade of shoe-makers, or of tailors, or the occupation of writing clerks, or accomptants, as well as of literary people in general. Some years ago, from the pressure of their stays, women were frequent sufferers in the same way: in the present fashion of their dress they are far less subject to it, though it occasionally happens to those who sit long stooping to needle-work.

By this proclination of the body, the thoracic and abdominal viscera are unduly compressed together for many hours in every day: the margin of the ribs is forced upwards so as to drive the stomach against the diaphragm, and to impede the passage through the pylorus; while all the adjoining organs, the blood vessels and excreting ducts partake of the general injury from the compression, and hereby concur to excite affections of the lungs, or permanent disease in the large vessels near the heart, as well as more extensive and deeply seated mischief in the stomach.

The symptoms indicating disease of the stomach from this cause, are nauseous taste in the mouth, with furred tongue, pain in the region of the pylorus, and sense of weight and the pain increased on pressure at the pit of the stomach: there is always costiveness; from the want of free passage through the pylorus the stomach becomes loaded with viscous matter: the countenance is pale, wan, and sallow, and very shortly blackness appears under the eye,

lids, and frequently a jaundiced tint appears from obstruction to the free secretion or passage of the bile, and all the common dyspeptic symptoms occur.

It is obvious, in all these cases, when the occupation of the patient will allow of avoiding that posture, which is the sole cause of his malady, that this is all which is necessary to prevent its return: from the force of habit, however, directions to this effect are seldom sufficiently obeyed: where the case has been of long standing, or there have been frequent repetitions of the attacks, and the lungs, liver, and other viscera, some or all of them become affected, the treatment must be adapted to the state of those parts: riding on horseback daily will do much service; and many a working tradesman, having lately entered into some corps of volunteers, has learned to carry his person better, and been afterwards free from this complaint; whilst, before he had the drill-serjeant's assistance, it was difficult to make him stand erect at any time.

The overfilled stomach, which brings the patient into an apoplectic state, is a case which requires the instantaneous exhibition of the most powerful emetics. A strong solution of vitriolated zinc is the most proper medicine for this purpose; it is preferable to any form of antimony, because the latter, even in a very large dose, will commonly have no emetic effect at all in the torpid state of the stomach, which is here the alarming symptom, but the patient will be thrown by it into a violent debilitating perspiration, and the time for relieving his stomach and saving his life will be lost for ever. As soon as the stomach is relieved, and the efforts to vomit have ceased, a large dose of some purgative medicine, and especially of the mercurial class may be advantageously exhibited: and the exhaustion of the power of the stomach must afterwards be attempted to be recovered by a regimen of warm and acrid stimulants, especially horse-radish, mustard, garlic, and onions; with the occasional use, as well in the former, as in the present consequence of the impletion, of gum pill with aloës, or a very small quantity of calomel.

HYPOCHONDRIASIS AND SICK HEAD-ACH: *the disease of erudition and study.*

The elegant and accurate Aretæus expresses himself to the following effect, in this very valuable chapter on diseases of the stomach.

"The stomach is a grand sect of pleasurable feelings and of disquietude. When its action is perfect, firmness and elasticity of fibre in conjunction with a ruddy complexion indicate health, and the digestion is easy. On the contrary, when the stomach is disquieted, there is an aversion to food; not only when it is placed on the table, but to the very thought of it, and dejection of mind is the consequence of insufficient nourishment; nausea, anxiety, collections of fluid in the stomach, and cardialgia ensue, and sometimes increased flow of saliva and vomiting. Though the whole body suffers while the stomach remains empty, yet greater suffering is produced when necessity has required food to be taken, and it is masticated with aversion, and swallowed with still greater disgust, and pain more intolerable than hunger ensues, and the pain between the shoulders increases; dimness of sight, tingling of the ears, and heaviness of the head take place, with torpor of the limbs, feebleness of the extremities, and sensations of palpitation about the præcordia; patients feel themselves agitated, and as it were driven to and fro like reeds or trees by a gust of wind; they are sleepless, though heavy and ready to fall asleep in a state resembling coma; they are meagre, pale, languid, deprived of strength, inactive, inanimate, and indolent, but they are suddenly excited to anger: their situation much resembles that of melancholia, with which disease they frequently become affected."

Aretæus proceeds to state the causes of the affection he has described: it attacks those, he says, who from necessity have lived on thin and spare diet, and those of laborious and patient erudition, who are so absorbed in the precepts and practice of philosophy as to hold in contempt a plenty and variety of nourishment; they never change the scene, or take exercise, or indulge in any relaxation of mind; their love of learning detaches them from every other consideration, from their country, their parents, their kindred, from themselves for the whole of their lives; pale and wan at all times; in youth they have all the infirmities of age; their mind, from exhaustion, becomes enervated and cloudy, and they seldom indulge in cheerfulness, and laughter and mirth are strangers to them.

Such is a faint and very indifferent sketch of the admirable picture drawn by Aretæus, so far as it applies to modern hypochondriasis, as proceeding chiefly from un-

due mental labour and exertion. To persons of this character it does not often happen that the symptoms they experience are the sole result of poor feeding from necessity: yet it certainly does occur to hypochondriacs to have their complaints aggravated from want of regular meals, and many persons fall into this disease in a great measure from never thinking of taking any sustenance till their very late hour of dinner; and when the disease has prevailed for some time, they frequently form rules of diet for themselves, or derive them from the advice of all whom they may have occasionally consulted, and they very commonly attend more to the cautions they have received against the *lædentia* than to any encouragement as to the *juvantia;* they depend for restitution of health on avoiding all that has been pointed out to them as wrong, and will scarcely believe that much benefit is to be derived from a good light meal or from taking at intervals any small quantity of exhilarating nourishment.

Most of the symptoms already enumerated under acidity of the stomach, make their appearance in the present disease, though varied in every diversity of combination: in addition to which there is generally costiveness, and a peculiar affection of the head, a dead heavy pain, sometimes exacerbated to acute distress, and always accompanied with that idiopathic nausea of the stomach, which is well characterised by the name of sick-head-ach.

The affection of the mind in hypochondriasis is curable, or may be very much palliated by due care and attention to the digestive process; persons thus affected are always disposed to view only the gloomy side of objects: according to the different circumstances and situations in life of each individual, he becomes oppressed with the fear of disease, of poverty, of death, of fatuity, of loss of memory, or has other groundless fears of misery awaiting him; such paroxysms will sometimes occur several times every day, and are often found to depend on indigestion and flatulency, which being removed by the means to be pointed out in the plan of treatment, these ideas of apprehended evils will gradually subside, or, at least, be very considerably diminished.

In all cases of this kind, whether of original affection of the primæ viæ, or symptomatic of chlorosis, or any other affection, little good can be done without unremitting attention to the regularity of evacuation from the bowels, which is essentially necessary to the subduing of acid when habitually formed in the stomach, and towards gaining any ground in the removal of pain, flatulency, and every other dyspeptic symptom, and the means of attempting to affect this regularity in different persons, and in the same person at different times, must be exceedingly varied; now and then a case occurs with an habitually lax state of the bowels, and only rhubarb is requisite as a purgative, joined with light aromatics, but commonly we have to contend with constipation, and rhubarb by itself does mischief. When the stomach and bowels are loaded and foul, powerful doses of mercurial purgatives are occasionally necessary, particularly in those whose blood-vessels are full, and whose energies are considerable. When this state of the system is indicated by labouring action of the heart, which is perceived by the patient, or by vertigo, depending upon repletion of the blood-vessels, it is to be relieved by cupping: and if the secretion of the bile be deficient or irregular, the repetition of a grain of calomel daily, or every other day, for a week or two persisted in, will be frequently found of great utility.

Yet it often happens that the bile, though duly secreted, is an insufficient stimulus to the intestines, either from its being neutralised by the acid which passes from the stomach to the duodenum, or from the bowels being in a state too permanently torpid to be excited by it. In such cases the repeated use of calomel, as a stimulus to the liver, cannot fail to be injurious: the intestinal canal itself should be chiefly attended to, and purgatives of a liquid kind, or those easily rendered liquid, should be employed in its stead. About a tea-spoonful of the tincture of senna rendered more grateful to the stomach by the admixture of a little tinct. of lavend. or of ginger, and taken at bed-time without any admixture of water, will often cause a more easy night's rest, and operate mildly in the morning; this is very useful in preventing the necessity of the too frequent repetition of more bulky or violent cathartics. On the same principle, electuary of senna and the various domestic preparations of that drug and of other mild laxatives have their uses; for it is always to be remembered that violent purging is not the intention to be accomplished, but only permanent regularity of evacuation. The aid of clysters should sometimes be obtain-

ed, particularly when there appears to be a large collection of indurated fæces in the colon: this is sometimes evident from a hardness in the track of this intestine, which may be felt in the umbilical and left iliac regions; and this congestion alone has not unfrequently produced strong hypochondriac symptoms.

Yet injections too long and habitually indulged in, are, of themselves, apt to produce costiveness; and are one grand cause of that constitutional constipation to which a great part of the French nation are so subject.

Aloes would be a convenient medicine, but that the diseased now under consideration, from a general torpidity of alvine action, are peculiarly disposed to hæmorrhoids; a malady which is almost always increased, instead of being meliorated by aloetic purgatives. Magnesia is seldom useful, whether alone or in combination. Calcareous earths often produce febrile heat, and augment the impediments to digestion. In some cases, however, of very chronic acidity, and when the bowels are tolerably free, considerable advantage may be derived from lime-water prepared with oyster-shells, as a purer form of calcareous earth than that which is dug out of a chalk-pit; and from bark prepared with lime-water. The addition of natron, or aq. kali, to bark or other bitters, is sometimes advantageous, particularly if the case be complicated with glandular affection; in the same manner soda-water is beneficial, and from the tonic power of the light carbonic acid it contains; the good effect of ammonia taken into the stomach, may depend in some measure on its alkaline nature, but seems principally to be produced by its grateful stimulus, both in the form in which it is taken, and after it may have been combined into a neutral ammoniacal salt by union with any acid it may meet with. Nothing, however, can be more capricious than the stomach in hypochondriacs, and in all these diseases where acidity habitually prevails: it is particularly to be noticed that vitriolic acid, with bark or without it, is often essentially useful, and this, where acidity in the stomach is continual; the utility of this acid is certainly in defiance of all chemical reasoning, and may depend upon its astringency, whereby it probably prevents the secretion of acid fluid into the stomach, or of such fluid as is ready to become acid, and in some measure on its power of preventing fermentation. Tonics for the most part are necessary, but it is almost impossible to lay down any form of them to be pursued for any length of time; the stomach is commonly soon disgusted with any individual preparations, and it is often very difficult to suit its variation of aptitude by the most judicious changes of medicine, which, however, must always be attempted, since there is not any case of disease which is so frequently aggravated by neglect.

Steel is a doubtful medicine. Where the head is chiefly affected it is sure to do harm. And even in cases in which we may conceive that some chalybeate water, as that of Tunbridge, or some chemical preparation of steel may be employed, it will be necessary to discontinue their use for some time, on the first approach or return of the affection of the head. When the spasm affects the voluntary muscles of the body the trial of steel is indicated, and its use appears sometimes considerably to contribute to the prevention of the return of dyspeptic symptoms and of pain in the stomach, as well as to the general tone and strength.

The spasms about the hypochondria very frequently cannot be relieved without opium, and in this case also the solid form of it is the best, as it is applied constantly by gradual solution to the parts immediately affected, and produces much less injury to the stomach and to the system than if given in a fluid state. Yet in neither way should we have recourse to it but when impelled by the supreme command of dire necessity; for at best it is but a temporary remedy, and the irritability generally returns with augmentation from its use. In cases of less extremity the fetid gums in the form of pills, camphor, æther, and Hoffman's anodyne liquor, will be often found highly serviceable, and will prove innocent of the baneful effects of opium. Flatulency is often much relieved by increasing the muscular action of the stomach and intestines; and mustard, horse-radish, and other such stimuli are useful, either in the forms in which they are served at table, or the mustard-seed may be taken whole, or the officinal and other preparations of horse-radish may be employed. In cases of sick-head-ach opium must, as much as possible, be avoided; to increase the power of the stomach and regulate the bowels are here the principal objects.

With regard to external remedies, blisters and other applications soliciting a dis-

charge, are commonly very unnecessary torments, and are very seldom justly applicable. Frictions on the hypochondria with volatile liniments often give very considerable relief. Cold bathing has been advised, but generally seems to disagree with persons of a sedentary constitution, especially if advanced in years.

Upon air and exercise much has been written; and some things have been written erroneously. The air of large cities is indisputably injurious to all debilitated invalids; and to hypochondriacs a pure air is peculiarly to be recommended. Yet seclusion is so baneful that the good effects of a purer air will be more than counterbalanced if an hypochondriac shut himself up constantly by his fire-side in his country study; or retire from society into indolence and apathy. Cold piercing winds are severely felt, and should be avoided: at the same time the propriety of hypochondriacs accustoming themselves to bear the open air as much as circumstances will allow, must ever be impressed upon them; and proper warmth of clothing, particularly about the feet, must be worn.

Exercise, short of fatigue, is essential; and even a little fatigue must be endured by those who, from long sedentary occupation, have lost the habit of exertion; riding on horseback, or in a carriage, sailing, rowing, are all useful; also moderate walking, bowling, or working with a spade in the garden, and other exercise out of doors attended with some labour. It is to be observed, however, of sick-head-ach, that its attacks are frequently induced by the motion of a carriage, boat, or ship, and that exercise on foot or horseback is best for such invalids: friction about the hypochondria with a flannel or flesh-brush, is often serviceable, and to be recommended when the debility of the patient prevents other kinds of muscular action. The military exercise, as practised by our volunteers for a short time every day, is also, where it can be adopted, of very high advantage.

The plan of diet in this disease is a point of much delicacy and management: the same mode will seldom answer for any two distinct cases. In general the patient is to be nourished with whatever ailment he can digest; and an equal and uniform reservation as to spices is by no means necessary, provided that they seem to improve, rather than to injure digestion; his appetite for a moderate quantity of almost any variety of food is to be indulged, provided no derangement of the stomach ensue from it, and the *juvantia* and *lædentia* are to be made out from observation in each case; vinegar and native vegetable acid commonly are prejudicial, yet very frequently ripe fruit is beneficial. In general every thing that is oily or empyreumatic must be avoided; mustard, horseradish and the like, are often useful in the prevention of flatulency; sometimes in long cases of hypochondriasis, where vomiting has been a tiresome symptom, the yolks of eggs boiled hard have been digested, and the vomiting in a short space of time has ceased; in these cases it is probable that the stomach is in an habitual state of contraction, as it has been sometimes actually found on dissection, and mustard or horse-radish, by increasing its muscular action, would have been injurious, whilst any easily digestible substance nearly solid from not occupying much space would be retained, and gradually distend the stomach, or, from causing the muscular effort produced in vomiting to cease, give opportunity to the stomach to recover its natural dimensions; eggs, however, prepared in any way that has been contrived, will not always agree, even when this state of stomach is to be suspected; but will at times be almost immediately rejected, or produce much disturbance, when a small quantity of gelatinous or mucilaginous food, or even of light meat, will be digested.

It is by no means justifiable to prohibit light suppers peremptorily; since, in point of theory, we know that digestion and the absorption of chyle proceed more regularly during sleep than at any other time; and, in point of fact, we know equally that hypochondriacs are often benefited by light suppers. Thus much is certain, that the meals should always be light and sparing, and consequently frequent; and that, if suppers be indulged at all, the hour of dinner should be much earlier than is customary in the present day.

With respect to drinks, malt-liquor ought but seldom to be allowed. Soda-water with wine, commonly forms a most excellent beverage. It is rarely proper to require any large quantity of diluting drink to be taken. Coffee generally agrees better than tea; and sometimes cocoa, or even chocolate, if its oily quality do not offend the stomach, is very proper for breakfast, or in the forenoon.

Opium, for the mere purpose of procur-

ing sleep, should never be allowed. Much, in this respect, is to be accomplished by regularity in the hours of rising and going to bed, and especially by opposing all propensity to sleep in the day time.

The mind in hypochondriasis cannot be properly regulated without the best efforts of the patient himself, but he will for the most part be induced to use them, on the representation of a medical man of intelligence and good humour, that it is impossible for him to accomplish any plan he has in view, and that he must always be a burthen to himself and his connections, till he makes the search after cheerfulness and health his primary pursuit; he must make himself alive to the scene which passes before him, and his family may commonly be instructed in some methods of diverting his attention from dismal reflections on himself, and from unremitting application to any favourite topic, and gently to remind him of the harm he is about to do himself, when he seems ready to give way to any excess of passion. His resort to public places will be beneficial when he can be brought to attend to what is going forward there, and by such attentions his pursuit of health will daily become less irksome and laborious; and by the same means he must be brought to unbend his mind in the society of his equals, and to attend to the proper times of exercise, food, and rest.

HEPATIC AFFECTION, *catenating with affection of the stomach, and produced by hot climates or hard drinking.*

We have already sufficiently commented upon the general nature of the bile, and the importance of its due and healthy flow towards the proper action of the stomach, and the whole of the intestinal canal. Now it is clear that if the organ which secretes this important fluid be perpetually irritated by a stimulus of every kind whatever, it will, first become inflamed, and suppurate if the inflammation be very great and progressive; and secondly, it will become wholly exhausted and torpid, if the stimulus be not sufficient to produce inflammation.

The stimuli of hot climates and of hard drinking, especially when the beverage consists largely of alcohol, have both a tendency to produce each of these effects, though not in an equal degree; and consequently not merely to injure the liver itself but to derange the entire process and economy of digestion.

In general those who are affected by a diseased state of the liver in warm climates return to their native homes before inflammation sufficient to excite suppuration has taken place; and hence in our own country we seldom meet with cases of this kind: but if the same persons do not return home in time, or if they be actually prevented from returning at all, suppuration will be a frequent consequence of the disease they are labouring under: and it is therefore a result which is by no means uncommon in the East and West Indies.

Commonly, as the case appears to us, on the arrival of the patient in Europe, the morbid excitement of the liver has only produced an enlargement of its parenchyma by the effusion of coagulable lymph: which is often re-absorbed by a recovery of healthy action in the lymphatics of the affected viscus, and especially by gently stimulating them through the medium of mercury. In the meanwhile, however, the stomach and the whole of the digestive economy suffers severely, and much attention is necessary to the nature and regulation of the diet.

The excitement produced by hard drinking, has a worse tendency, and is often succeeded by a worse result to the stomach, liver, and indeed all the chylopoietic viscera, than that produced by hot climates. For, though in the former case, we have seldom morbid action enough to produce suppuration, we have enough to excite schirrus, in conjunction with torpidity, and consequently to render the organs almost incapable of recal to a healthy and harmonious state by any kind of regimen, or plan of medicine whatever. While, at the same time, the villous membrane of the stomach from perpetual exposure to the acrimony of alcohol, becomes abraded of the mouths of its secerning vessels, and rendered often polished and glabrous throughout its whole surface, like a sheet of glass; whence the stomach is just as incapable of secreting gastric juice as the liver is of secreting bile.

The symptoms chiefly indicatory of an affection of the liver from a long residence in hot climates, are, costiveness, often alternating with diarrhœa, or dysentery: strong spasmodic pains about the epigastrium, and hypochondria; flatulence, and at times cardialgia. There is also a general languor and depression altogether intolerable and insuperable to the patient. If he indulge in activity he sinks into a state of increas-

ing debility, and if he attempt any moderate exertion he is overcome by fatigue, or suffers from cold, or from some new symptoms, the consequences of accidentally increased action; and unless some effectual, but moderate and permanent means of relief, be afforded, he dies of some symptomatic disease which ensues, or sinks exhausted by the primary affection of the stomach and other viscera concerned in digestion. Such are the most striking features of disease originating from this state of the abdominal viscera, when it is severe and permanent. In the more common attacks a great number of symptoms are very troublesome: nausea, cardialgia, eructation, faintness, sense of weight, and oppression in the epigastric region, which is tender to the touch, and pain between the shoulders. In almost every case, the appetite is exceedingly fastidious; if food be not taken, flatulency and sense of languor increase, and the spasm becomes severe; and after eating, all the symptoms of dyspepsia occur, and the pain very often is aggravated.

Those who, during their residence in a hot climate, have been attacked by acute inflammation of the liver, not terminating in suppuration, are frequently found on their return to Europe, as we have already observed, to have the liver enlarged from the deposition of coagulable lymph in the progress of the inflammation, and in its termination by resolution; in the same manner as the testicle, and particularly of the epididymis which remains for a long time enlarged after the inflammation called hernia humoralis: it is seldom, however, that these symptoms will not yield to a judicious and persevering mode of medical practice.

In affections of the stomach and other chylopoietic organs from hard drinking, the chief of the same symptoms will be found to occur; but those peculiarly attendant upon this last disease, perpetual loss of appetite, nausea and vomiting when the stomach is empty; an almost constant pain at the pit of the stomach; a general tremulation of the muscles, and especially those of the hands and arms, so that nothing can be held steady; vertigo, and frequent fainting fits.

In the case of enlarged liver, from the deposit or accumulation of coagulable lymph, mercury should be administered so freely and reiteratedly as to produce immediate and permanent action on the liver, and rather by inunction on the abdomen than by the mouth; or perhaps by both at the same time. Yet the exhibition of mercury in large quantities, and so as to excite ptyalism has of late years become too indiscriminate; and excepting in the individual case now alluded to, its admission in this unrestrained manner will be generally doubtful, and often unquestionably injurious. In all other cases, when its use is at all indicated (and it is seldom that it is not indicated) it should be administered in small doses, seldom exceeding the quantity of half a grain of calomel once or twice a day: and the plan thus begun should be persevered in for weeks or months—in effect till a radical cure be obtained, if it be obtainable at all. Into the rationale of this progressive system we cannot fully enter at present: it may not, however, be amiss to observe, that in every case the chylopoietic organs have a much better chance of being restored to a sound and healthy state by progressive gentleness than by sudden violence; that the permanent solicitation of a comparatively mild stimulus will eventually accomplish what a more forcible system can never produce; and that hence the latter should be reserved for mere cases of decided extremity.

Aperient medicines are almost always necessary, from the great irregularity of the bowels, and generally an habitual propensity to costiveness. Dr. Stone has lately opposed the use of castor oil, which has hitherto been in great vogue, as well from the inaccuracy with which it is generally expressed, as from its acting chiefly on the large, and but little or not at all on the small intestines. But after all, the patient must determine for himself; for though it may disagree with many constitutions, it will often occur in others that there is no aperitive that completes its purpose so pleasantly. When castor oil does not agree, a little rhubarb in combination with neutral salt, in the proportion of a scruple or half a dram of the former, and a dram of the latter, dissolved in mint water, may be resorted to, or the neutral salt alone in double the quantity now prescribed.

Where we have reason to suspect schirrosity of the liver, purgatives are of more consequence than in any other case: and here the more drastic kinds are to be preferred: as jalap, colocynth, and scammony.

Peruvian bark seldom agrees with the stomach in any stage of this disease, but bitter tonics will usually sit easy, and often afford considerable relief. If the pain be

violent, opium must necessarily be had recourse to, but never otherwise.

When the sense of sinking in the stomach is distressing, and particularly when this symptom occurs with cardialgia, the best stimulus is the compound spirit of ammonia, in camphor mixture, or in some other light vehicle; this is much less injurious to the digestive organs, than æther or any other strong spirituous preparation, or than aromatic confection, or any other spice in large quantity; and it is frequently useful in conquering the patient's habit of taking high-seasoned dishes: it is sometimes not only useful but necessary to be gradual in breaking this habit, and it is commonly best to allow a few glasses of generous wine, requesting the patient at the same time to avoid all spirituous liquor; a little wine is often well applied, as it stimulates him to take food which he would not otherwise touch, and enables him to digest it more easily. Here the diet cannot be too plain and simple: rice is one of the best vegetables, whether in gruel or in a solid form, and should be duly intermixed with animal food, either roasted or boiled at the patient's option.

Bath water in moderation, and with strict attention to the state of the bowels, often proves an excellent restorative. Soda water is one of the best beverages that can be prescribed. Much walking usually induces dropsy, and should therefore be avoided; moderate exercise, however, is of high importance, and it may be varied with great advantage by riding on horseback, in a carriage, and short excursions on the water.

There are several other diseases which are also dependent upon a vitiated state of the digestive organs, and are peculiarly the objects of dietetic medicine. But, in general, they will be found of less consequence, and more easily subdued: they will be characterised by the slighter symptoms attendant upon those already noticed, and will yield to the common plan of medical regimen prescribed for their cure.

DIFFERENCES, in heraldy, certain additaments to coat armour, whereby something is added or altered to distinguish younger families from the elder.

Of these differences Sylvanus Morgan gives us nine; *viz.* the label, for the first son; the crescent, for the second; the mullet, for the third; the martlet, for the fourth; the annulet, for the fifth; the flower-de-lis, for the sixth; the rose, for the seventh; the eight-foil, for the eighth; and the cross-moline, for the ninth.

Again, as the first differences are single for the sons of the first house or descent, the sons of the younger house are differed by combining or putting the said differences upon each other. As the first differences are the label, crescent, &c. for the first house, the difference for the second house is the label on a crescent for the first of that house; for the third brother of the second house, a mullet on a crescent, &c.

DIFFERENTIAL *calculus*. See CALCULUS.

DIGESTER, an instrument to dissolve solid animal substances, in a manner somewhat similar to that performed by the stomach. The vessel was invented by Papin: hence it is usually called "Papin's Digester." After putting meat into it, together with a sufficient quantity of water, a lid is closely screwed on, so as to admit no external air. By a moderate fire the meat will, in the course of six or eight minutes, be reduced to a perfect pulp: by augmenting the heat of the fire, or extending the time of digestion, the hardest bones may be converted into a jelly. To these machines there is also a safety valve, which should always be kept in good order; for if, by any means, it is put over the fire, and the valve incapable of opening, the most fatal consequences may happen from the immense power of confined steam.

DIGESTION, in animal economy. An important distinction exists between animals and vegetables, in the mode in which they receive their nourishment. Vegetables are constantly absorbing matter from the soil; it immediately passes into the sap vessels, and is soon changed by respiration and secretion. Animals, on the contrary, with very few exceptions, take in food at intervals, and retain it in their stomach for a considerable time, where it undergoes a chemical change, which constitutes the function of digestion, the first step in the general process by which animal matter is formed. See PHYSIOLOGY.

DIGESTION, in chemistry, an effect produced by the continued soaking of a solid substance in a liquid, with the application of heat.

DIGIT, DIGITUS, in astronomy, the twelfth part of the diameter of the sun or moon, is used to express the quantity of an eclipse. Thus an eclipse is said to be of six digits, when six of these parts are hid.

DIGIT is also a measure taken from the breadth of the finger. It is properly three-fourths of an inch, and contains the measure of four barley corns laid breadthwise.

DIGITS, in arithmetic, signify any integer under 10, as 1, 2, 3, 4, 5, 6, 7, 8, 9.

DIGITALIS, in botany, English *fox-glove*, a genus of the Didynamia Angiosperma class and order. Natural order of Luridæ, Linnæus. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla bell form, five-cleft, bellying; capsule ovate, two-celled. There are twelve species. These are large plants, with alternate leaves and flowers in spikes at the ends of the stem and branches. D. purpurea, purple fox-glove, is biennial; the stem is from three to six feet high, upright; leafy, round, pubescent; leaves alternate, acute, veiny, and wrinkled underneath; flowers in a long spike, nodding, imbricate, all directed the same way; peduncles one-flowered, pubescent, thickest at top; calyx also pubescent; corolla purple, the bellying part sprinkled on the inside with spots like little eyes; filaments a little broader at top, crooked at bottom; anthers large, cloven almost to the base, yellowish, and frequently spotted; stigma bifid; nectary a gland, surrounding the base of the germ; seeds dark brown, truncate at both ends. It is a native of Denmark, Germany, Switzerland, Britain, in sandy and gravelly soils; near London it grows plentifully. It flowers from June to August.

DIGITATED, among botanists, an appellation given to compound leaves, each of which is composed of a number of simple foliola, placed regularly on a common petiole; though, strictly speaking, there must be more than four foliola to make a digitated leaf.

DIGNITARY, in the canon law, a person who holds a dignity, that is, a benefice which gives him some pre-eminence over mere priests and canons. Such is a bishop, dean, archdeacon, prebendary, &c.

DIGNITY, as applied to the titles of noblemen, signifies honour and authority. As the omission of a name of dignity may be pleaded in abatement of a writ; so may it be where a peer or nobleman, who has more than one name of dignity, is not named by that which is most noble.

DIGYNIA, the name of an order or secondary division in each of the first thirteen classes, except the ninth, in Linnæus's method; consisting of plants, which, to the classic character, whatever it is, add the circumstance of having two styles or female organs.

DILAPIDATION, is where an incumbent of a church living suffers the parsonage-house or out-houses to fall down, or be in decay for want of necessary reparations; or it is the pulling down or destroying any of the houses or buildings belonging to a spiritual living, or destroying of the woods, trees, &c. appertaining to the same; for it is said to extend to committing or suffering any wilful waste, in or upon the inheritance of the church.

DILATATION. See EXPANSION.

DILATRIS, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: calyx none; corolla six-petalled, hirsute; filaments one less than the others; stigma simple. There are three species, all natives of the Cape.

DILEMMA, in logic, an argument consisting of two or more propositions, which divides the whole into all its parts, or members, by a disjunctive proposition, and then infers something concerning each part, which is finally referred to concerning the whole.

DILL. See ANETHUM.

DILLENIA, in botany, so named in honour of J. J. Dillenius, professor of botany at Oxford, a genus of the Polyandria Polyginia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx five-leaved; petals five-cleft; capsule many-seeded; connate filled with pulp. There are seven species. These are very handsome trees, natives of the East indies; the leaves are large, and of a leathery substance; the flowers are axillary or terminating, and frequently very large.

DIMENSION, in geometry, is either length, breadth, or thickness; hence a line hath one dimension, *viz.* length; a superficies two, *viz.* length and breadth; and a body, or solid has three, to wit, length, breadth, and thickness.

DIMINUTION, in rhetoric, the exaggerating of what you have to say by an expression that seems to diminish it.

DIMINUTIVE, in grammar, a word formed for some other, to soften or diminish the force of it, or to signify a thing is little in its kind. Thus cellule is a diminutive of cell, globule of globe, hillock of hill.

DIMORCARPUS, in botany, a genus of the Octandria Monogynia class and or-

der. Calyx five-cleft; corolla five-petalled; berries two, one-seeded, large. One species, found in China.

DIMORPHA, in botany, a genus of the Diadelphia Decandria class and order. Natural of Papillonaceæ or Leguminosæ. Essential character: petals one large convolute, in place of the keel; standard and wings none. There are three species, natives of the woods and banks of rivers of Guiana.

DIOCESE, the circuit of every bishop's jurisdiction. For this realm hath two sorts of divisions; one into shires or counties, in respect of the temporal state; and another into provinces, in regard to the ecclesiastical state; which provinces are divided into dioceses. The provinces are two; Canterbury and York, whereof Canterbury includes twenty-one dioceses, or sees of suffragan bishops; and York three, besides the bishopric of the Isle of Man, which was annexed to the province of York by king Henry the Eighth.

DIODIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form; capsule two celled, two seeded. There are six species, most of them natives of the West Indies.

DIODON, in natural history, a genus of fishes of the order Cartilaginei. Generic character: jaws bony and undivided; aperture of the gills linear; body covered on all sides with long moveable spines; no ventral fins. There are three species according to Gmelin, and five according to Shaw.

D. hystrix, or the sea porcupine, as it is termed popularly, grows to nearly two feet in length, and inhabits the Indian and American seas. In some of the West India islands it is used for food, but, in general, is little valued. Its resemblance to the porcupine and hedge-hog, and likewise to the sea-urchins, is considerable both in appearance and manners. It possesses the faculty of raising and depressing its spines at pleasure, and likewise of flattening its body, or extending it to a globular form, and is often fished for with a rod and line merely for the sake of the curious spectacle it exhibits by these violent alternations. On first perceiving the hook, it appears agitated by the extreme of rage. Its spines are erected with the utmost intenseness, and its body is swelled to the form of a ball, and thus, for a considerable time, it moves rapidly in various directions, as if surprised and maddened by the failure of all its efforts at revenge and extrication. Being at length exhausted, its spines are levelled, and the air is expelled from its body, which, from the form of a globe assumes that of a wafer. Its strength, however, is partially renewed before it is drawn on shore, and it exhibits again all the intensity and fierceness of its agitation in the repetition of the symptoms above described, in which state it is thrown upon the land, and there suffered for some time to remain till the langours of death prevent the possibility of injury, and extinguish at once its resentments and vitality. See PISCES, Plate IV. fig. 1.

DIŒCIA, two houses. The name of the twenty-second class in Linnæus's sexual method, consisting of plants, which, having no hermaphrodite flowers, produce male and female flowers on separate roots. These latter only ripen seeds, but require, for that purpose, according to the sexualists, the vicinity of a male plant, or the aspersion of the male dust. From the seeds of the female flowers are raised both male and female plants. The plants then in the class diœcia, are all male or female; not hermaphrodite as in the greater number of classes; or with male and female flowers upon one root, as in the class monœcia of the same author.

DIOMEDEA, the *albatross*, in natural history, a genus of birds of the order Anseres. Generic character: bill strong, bending in the middle, and hooked at the end of the upper mandible; the lower mandible truncated; nostrils oval, wide, prominent, and covered with a large convex guard; tongue hardly perceivable; toes three, and all placed forward. There are four species, of which we shall notice, the

D. exulans, or the wandering albatross. This bird is an inhabitant of not only many countries between the tropics, but also beyond them both to the north and south. It is found in Kamtschatka, and is particularly abundant at the Cape of Good Hope. Its weight is from twelve to twenty-eight pounds; its length is occasionally four feet, and its extent, from wing to wing, ten. Its sounds are harsh, and thought not a little to resemble the braying of an ass. Its arrival at Kamtschatka is regarded as an infallible presage of the speedy arrival of shoals of fish, and upon these, however, emaciated when it arrives, it fattens within a very short time. It feeds, indeed, with uncommon voracity, and will often attempt to swallow a fish of four pounds weight, the

tail, however, of the fish protrudes from the mouth of the bird till the head is digested, and, in the interval, the bird is so unweildy and defenceless, that it is easily destroyed by the natives. It quits Kamtschatka in August, never having been certainly known to build there. In Patagonia and the Falkland Islands its nest is made on the ground, with earth, a foot in height, and of a circular figure. While the female sits, the male is incessant in his assiduities to provide for her subsistence, and both are so tame as to permit any person to push them from their nest, and deprive them of their eggs without the slightest resistance. The hawk is perpetually vigilant for the removal of the female, during which it darts on her nest, and purloins her treasure. The grey gull takes a more daring aim, and assails the albatross itself, attacking it beneath, to prevent which, that bird, when in danger from this gull, flies immediately to the water, and seldom leaves the surface for distant flights, unless in the seasons of its migration. The nests of the albatross, when vacated by them, are immediately occupied by the penguin. Albatrosses have been seen by voyagers at the distance of 600 leagues from land. For the albatross, see AVES, Plate VI. fig. 3.

DIONÆA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Essential character: calyx five-leaved; petals five; capsule one-celled, gibbous, containing many seeds. There is but one species, *viz.* D. mucipula, Venus's fly-trap, a native of North Carolina, in swampy places.

DIOPHANTINE *problems*, are certain questions relating to square and cubic numbers, and to right-angled triangles, &c. the nature of which were first and chiefly treated of by Diophantes in his algebra.

In these questions it is chiefly intended to find commensurable numbers to answer indeterminate problems; which often bring out an infinite number of incommensurable quantities. For example, let it be proposed to find a right-angled triangle, whose three sides, x, y, z, are expressed by rational numbers; from the nature of the figure it is known that $x^2 + y^2 = z^2$, where z denotes the hypothenuse. Now it is plain that x and y may also be so taken, that z shall be irrational; for if $x = 1$, and $y = 2$, then is $z = \surd 5$.

Now the art of resolving such problems, consists in ordering the unknown quantity or quantities, in such a manner, that the square or higher power may vanish out of the equation, and then by means of the unknown quantity in its first dimension, the equation may be resolved without having recourse to incommensurables. *e.g.* let it be supposed to find x, y, z, the sides of a right-angled triangle, such as will give $x^2 + y^2 = z^2$. Suppose $z = x + u$, then $x^2 + y^2 = x^2 + 2 \times u + u^2$; out of which equation x^2 vanishes, and $x = \frac{y^2 - u^2}{2u}$: then assuming y and u equal to any numbers at pleasure, the sides of the triangle will be y, $\frac{y^2 \times u^2}{2u}$, and the hypothenuse $x + u = \frac{y^2 \times u^2}{2u}$; if $y = 3$, and $u = 1$, then $\frac{y^2 - u^2}{2u} = 4$, and $x + u = 5$. It is evident that this problem admits of an infinite number of solutions.

DIOPSIS, in natural history, a genus of insects of the order Aptera. Generic character: head with two inarticulate filiform horns, much longer than the head, at the tip of which are placed the eyes. There is but one species, *viz.* D. ichneumonea, which resembles the ichneumon, and is found in South America and Guinea. It is of the size of an ant, and very remarkable for the singular appearance of the eyes, which appear seated at the tips of a pair of long processes, at first sight resembling antennæ.

DIOPTRICS, the science of refractive vision, or that part of optics which considers the different refractions of light in its passing through different mediums, as air, water, glass, &c. and especially lenses. See OPTICS.

DIOSCOREA, in botany, English *yam*, a genus of the Dioecia Hexandria class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: male, calyx six-parted; corolla none. Female, calyx six-parted; corolla none; styles three; capsule three-celled, compressed; seeds two, membranaceous. There are fifteen species. These plants have usually tuberous perennial roots, with twining stems from right to left; flowers axillary, in spikes or racemes. Several of these species are natives of the East and West Indies, where they are cultivated for food.

DIOSMA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Rutaceæ, Jussieu. Essential character: corolla five-petalled; nectaries five on the germ; capsule three or five conjoined; seeds veiled. There

are nineteen species. These are all shrubs, bearing the resemblance of heaths. The leaves are either opposite or scattered, frequently crowded and linear, sometimes having the edge underneath dotted. The flowers are in corymbs, or heads at the ends of the branches. The calyxes of some are glandulous and dotted. They are natives of the Cape of Good Hope.

DIOSPYNAS, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Bicornes. Guaiacanæ, Jussieu. Essential character: hermaphrodite; calyx four-cleft; corolla pitcher-shaped, four-cleft; stamina eight; style four-cleft; berry eight-seeded. Male, calyx, corolla, and stamina of the other. There are nine species, of which D. lotus, European date plum is a small tree, six feet high, with spreading branches; leaves ovate lanceolate, quite entire, large, alternate, smooth, with oblique prominent ribs; flowers pale, terminating, solitary, with a large leafy calyx four or five parted, flat, permanent; berry round, half an inch in diameter, yellow, lanuginose, one-celled, containing eight oblong compressed bony seeds, with very little pulp. The broad-leaved variety grows up into very large trees in the southern parts of Caucasus. It is also found abundantly on the whole coast of the Caspian Sea.

DIP, of the horizon, is an allowance made in all astronomical observations of altitude for the height of the eye above the level of the sea.

DIPHTHONG, in grammar, a double vowel, or the mixture of two vowels pronounced together, so as to make one syllable.

DIPHYSA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx half five-cleft; legume with a bladder on each side; seeds hooked. There is but one species, *viz.* D. carthaginensis, a small tree about ten feet in height, approaching to the arborescent mimosas. It is common every where about Carthagena in New Spain, flowering in August and September.

DIPLOMA, an instrument or licence given by colleges, societies, &c. to a clergyman to exercise the ministerial function, or to a physician to practise the profession, &c. after passing examination, or admitting him to a degree.

DIPLOMATIC *letters*. The art of reading letters written in cypher must be founded on a knowledge of the art of writing according to this method of concealment. In examining a piece in newly-invented characters, we should endeavour to ascertain whether the number of the characters correspond, or nearly so, with the ordinary number of alphabetical letters. We may sometimes detect a weakness in the writer of having selected his most simple marks either for the vowels or the first letters in the alphabet, and his complex marks for the consonants, or the letters most remote from *a*, *b*, *c*, &c. We must observe which of the characters, whether taken singly or combined, occur the oftenest in the whole specimen; and of these probably the most frequent will represent *e*, *a*, *i*, *o*; *e* being much more common than the rest of the vowels, but *u* and *y* are even less frequent than many of the consonants.

Endeavour next to ascertain the beginning and ending of words, which are sometimes distinguished by spaces or points, or the insignificant marks or nulls interposed; but however it be done, you must expect these signs to occur after every few letters, and the frequency of their occurrence may serve as some guide.

When you have found out the distinction between words, take particular notice of the order, number, frequency, and combination of the letters in each word; and first examine the characters of which the shortest monosyllables are composed. Remember, 1. That no word can be without a vowel: a word of one letter must therefore be a vowel, or a consonant with an apostrophe. 2. That the vowels are more frequently doubled at the beginning of words than the consonants: indeed the latter are only doubled at the beginning of Spanish and Welsh words. 3. That the vowels mostly exceed the consonants in short words; and when the double consonants are preceded by a single letter, that letter is a vowel. 4. That the single consonant which precedes or follows double consonants is *l*, *m*, *n*, or *r*. 5. That the letter *q* is always followed by *u*; and when two different characters occur, the latter of which is often joined with other letters, but the former never found alone, nor joined with any than the latter, those characters stand for *qu*, which two, except in a few Scotch names, are always followed by a vowel. 6. That although every language has something peculiar in its structure the foregoing observations will apply with little variation to all the European languages.

In the English let it be remarked, that *and* and *the* are more often found than any other words; *h* is frequently preceded by *w*, *c*, *s*, and *t*; *y* is seldom used in the middle of a word; the double letters *ll* and *ss* appear frequently at the end of words; *ed*, *ty*, *ly*, *ing*, and *tion* are very common terminations; *em*, *in*, *com*, and *con* are frequent prepositions; *a*, *i*, and *o* may stand alone; *o* is often followed with *u*; *e* is much more frequent in the beginning and end of words than in the middle; and in English the *e* is continually employed, as in *yes*; *yet*, *her*, *never*, *me*, *we*, *he*, *the*, *she*, *they*, *ye*, *fee*, *see*, *be*, *ever*, *speed*, *need*, *deference*, *excel*, *excess*, &c. Though this will not hold good in Latin, as *e* and *i* are equally frequent in the latter, and next to these *a* and *u*; but *o* not so common as any of them: and yet in the Spanish and Italian the *o* occurs very frequently. When you meet with a character doubled in the middle of a word of four letters, it will be necessary to consider what words of four letters are so spelled. It is probable the vowels *e* or *o* are these; as *meet*, *feel*, *good*, *book*, *look*, &c. In polysyllables, where a double character appears in the middle of a word, it is for the most part a consonant; and if so the preceding letter is always a vowel.

Observe also, that *i* in English never terminates a word, nor *a* or *u*, except in *flea*, *sea*, *you*, or *thou*: again, by comparing the frequency of the letters, you will generally find *e* occurs the oftenest; next *o*, then *a* and *i*; but *u* and *y* are not so often used as some of the consonants, especially *s* and *t*. Among the vowels *e* and *o* are often doubled; the rest scarce ever; and *e* and *y* often terminate words; but *y* is much less frequent, and consequently easily distinguished.

To find out one consonant from another, you must also observe the frequency of *d*, *h*, *n*, *r*, *s*, *t*; and next to these *c*, *f*, *g*, *l*, *m*, *w*; in a third rank may be placed *b*, *k*, *p*, and lastly *q*, *x*, *z*. This remark, however, belongs to English; for in Latin common consonants are the *l*, *r*, *s*, *t*; next *c*, *f*, *m*, *n*; then *d*, *g*, *h*, *p*, *q*; and lastly *b*, *x*, *z*. But the difficulty is to come at the knowledge of three or four letters; therefore, where a word of four letters has the first and fourth the same, it is most likely to be *that*: to discover which, look for another of four letters, beginning with the two first and ending with two others, and it will probably prove to be *this*; and more especially if you find another with three letters, beginning with the two first; for in that case it must be *the*. Now, having found out in any part of the cypher these three words, *that*, *this*, and *the*, place them over the characters which you know to be *t*, *h*, *a*, *i*, *s*, *e*, and then consider what letters are deficient, and what words, from the number of letters that composed them, they are most likely to be. You will thus find such ready and surprising intimations from the above six letters previously discovered, that you will soon be in possession of the whole alphabet.

When words of two letters appear of the same characters, differently placed, it is most likely one is *on* and the other *no*: so *of*, and *for*, and *from*, discover and ascertain each other; and *th* are very often used in the beginning of English words, as *thee*, *that*, *this*, *then*, *these*, *their*, *thirst*, &c. &c.

Besides these peculiarities, Mr. Falconer points out the following, as applicable to the English.

	Beginning a word is regularly followed by
A	most of the letters.
B	*a*, *e*, *i*, *l*, *o*, *r*, *u*, *y*.
C	*a*, *e*, *h*, *i*, *l*, *o*, *r*, *u*.
D	*a*, *e*, *i*, *o*, *r*, *u*.
E	most of the letters.
F	*a*, *e*, *i*, *l*, *o*, *r*, *u*, and sometimes *y*.
G	*a*, *e*, *h*, *i*, *l*, *n*, *o*, *r*, *u*, *y*.
H	vowels only.
I	most of the letters.
K	*a*, *e*, *i*, *n*.
L	vowels only.
M	vowels only.
N	vowels only.
O	most of the letters.
P	*a*, *e*, *h*, *i*, *l*, *o*, *r*, *s*, sometimes *t*, *u*, *y*.
Q	only by *u*, and *qu* by *a*, *e*, *i*, *o*.
R	*a*, *e*, sometimes *h*, *i*, *o*, *u*, *y*.
S	*a*, *c*, *e*, *h*, *i*, *k*, *l*, *m*, *n*, *o*, *p*, *q*, *t*, *u*, *w*, *y*.
T	*a*, *e*, *h*, *i*, *o*, *r*, *u*, *w*, *y*.
U	sometimes *d*, and *g*, *l*, *m*, *n*, *p*; sometimes *r*, *s*, *t*, *x*.
V	vowels only.
W	*a*, *e*, *h*, *i*, *o*, *r*, *y*.
X	sometimes *a* or *e*.
Y	*e*, sometimes *i*, *o*.
Z	*e*, sometimes *o*.

It would be too prolix in us to give an equally minute account of the particularities of other languages; but the inquisitive reader will find them very well specified in the "Cryptographia Denudata" of D. A. Conrad, 8vo., Lug. Bat. 1739, and in the latter part of Breithaupt's "Ars Decifratoria, sive Scientia occultas Scripturas solvendi et legendi," Helmst. 12mo. 1737.

To exercise the English scholar, we here subjoin one example of plain cyphering, in which two figures answer to each letter:

39. 38, 31, 21, 35. 35, 14, 20, 18, 21, 19, 20, 35, 34. 20, 38, 39, 19. 32, 35, 31, 35, 18. 22, 39, 20, 38. 13, 31, 14, 24. 20, 38, 39, 14, 37, 19. 31, 19. 20, 15. 20, 38, 35. 13, 31, 14, 31, 37, 39, 14, 37. 15, 36. 20, 38, 35. 31, 36, 36, 31, 39, 18. 18, 35, 17, 21, 39, 19, 39, 20, 35. 36, 15, 18. 24, 15, 21. 20, 15. 11, 14, 15, 22. 18, 35, 13, 35, 13, 32, 35, 18. 20, 38, 31, 20. 15, 14. 14, 15. 31, 33, 33, 15, 21, 14, 20. 24, 15, 21. 36, 31, 39, 12. 20, 15. 13, 35, 35, 20. 13, 35. 31, 20. 14, 39, 14, 35. 20, 15, 13, 15, 18, 18, 15, 22. 14, 39, 37, 38, 20. 36, 15, 18. 22, 35. 13, 21, 19, 20. 14, 15, 20. 14, 15, 22. 34, 35, 12, 31, 24. 20, 38, 35. 19, 21, 18, 16, 18, 39, 25, 35. 15, 36. 20, 38, 35. 33, 31, 19, 20, 12, 35. 22, 38, 35, 14. 20, 38, 39, 14, 37, 19. 31, 18, 35. 39, 21, 19, 20. 18, 39, 16, 35. 36, 15, 18. 35, 23, 35, 33, 21, 20, 39, 15, 14.

By practising the foregoing rules the student will find that this method of secret writing in plain cypher, may with as much ease, if not as much speed, be decyphered as written.

In all cases, begin first to decypher the single characters and shortest monosyllables; mark down on a separate paper any corresponding signs and letters you discover, and count the different characters throughout the piece, in order to compare their frequency, &c. It will generally, if not always, happen, that the most frequent is *e*.

In the whole of the preceding instructions it may be observed, that the suppositions of a single alphabet, and of the spaces between the words being discoverable, or the nulls few, have been made throughout. But it may happen that the spaces may have been very artfully concealed; that the nulls may be, at least, as many as the significant characters; and that both the one and the other, being more numerous than the letters of an alphabet may be intermixed, not only at the ends but in the body of all short words, and made to recur by a system of periodical change, which shall ease the writer of the burthen of their number, and nevertheless prevent the decypherer from having any considerable portion of similar writing to operate upon. When these and other difficulties are opposed to the exercise of the rules above laid down, the decypherer will have an opportunity of exercising his natural or acquired sagacity; and though the advantage may be on the side of the writer; yet the patience and continued trials of the decypherer will, in actual business, be often rewarded by discoveries, at which he himself will look back with surprise.

DIPLOMATICS, a word derived from diploma, in this instance signifying the King's letters patent, for the immediate expediting of an ambassador or envoy to a foreign court. The art of diplomatics has been cultivated with great assiduity by every nation in Europe for very many years past, and men experienced in political history, of engaging manners, and possessing a considerable share of duplicity, have always been selected by each to practise it. The principal aim of the *corps diplomatique* (as the French term ambassadors) is to discover the movements and intentions of their brethren, and to conceal their own; in order to accomplish this purpose, artifice, bribery, deceit, and prevarication, are more frequently necessary than open and manly conduct. This art has produced changes in states, surprising and calamitous, and often counteracted the hostile intentions of neighbouring nations, nor was it ever better understood and practised than at the present moment, as the sudden friendships, and unexpected enmities of the courts of Europe daily evince.

DIPPING, among miners, signifies the interruption, or breaking off, of the veins of ore; an accident that gives them a great deal of trouble before they can discover the ore again.

DIPPING *needle*. See MAGNETISM.

DIPSACUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Dipsaceæ, Jussieu. Essential character: calyx common many-leaved; proper superior; receptacle chaffy. There are four species; these are biennial, tall, herbaceous plants, prickly, terminated by rough heads of flowers; the leaves are sometimes connate at the base, forming a basin. D. fullonum, cultivated teasel, is reared in great quantities in the West of England, for raising the nap upon woollen cloths, by means of the crooked awns or chaffs upon the heads, which, in the wild sort, are straight. For this purpose they are fixed upon the circumference of a large broad wheel, which turns round while the cloth is held against them.

DIPTERA, in natural history, an order of insects in the Linnæan system. This order contains such insects as are furnished

with two wings only; such as flies, gnats, and a variety of other insects. Under each wing is a clavate poiser or balancer, with its appropriate scale. There are two sections, 1. A. with a proboscis and sucker, containing the following genera, *viz.*

Conops	Musca
Diopsis	Tabanus
Empis	Tipula

and B. with a sucker, but no proboscis: of this there are also six genera, *viz.*

Asilus	Hippobosca
Bombylius	Oestrus
Culex	Stomoxys.

DIPTERYX, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two upper segments winged; legume ovate, compressed, one-seeded. There are two species, *viz.* D. odorata, Coumarouna, and D. oppositifolia, Taralea. These are both tall trees; about sixty feet high; very much branched at top; the leaves are large, alternate, and pinnate; the leaflets are perfectly entire, two or three on each side, affixed alternately on the mid-rib; the flowers are borne in racemes, which are axillary and terminal; their colour is purple, streaked with violet. The almonds are fragrant, and are put by the Creoles into chests, in order to drive away insects, as well as for the sake of their smell. They are both natives of South America.

DIPUS, the *jerboa*, in natural history, a genus of Mammalia, of the order Glires. Generic character: two front teeth in the upper and in the under jaw; fore legs very short, hind legs very long; clavicles in the skeleton; tail long and tufted at the tip. Shaw enumerates six species, and Gmelin ten.

D. sagitta, or the Egyptian jerboa of Pennant, is about the size of a rat, and was known to the ancients by the name of the two-footed mouse. It is to be met with in various parts of Africa, and in the eastern provinces of Siberia. In its posture and movement it greatly resembles a bird. It stands on its hind feet, and rarely applies its fore feet to the ground, employing them almost exclusively in applying food to its mouth, in the same manner as the kanguroo. It inhabits subterraneous apartments prepared by itself, or found accommodated for its purpose, and reposes in them during the greater part of the day, choosing the night for excursion and food. It is, in the tropical climates, susceptible of cold, feeds upon various vegetables, such as it can procure amidst the barren and sandy wilds which it prefers for its habitation, and burrows with such extreme facility, that, in a state of confinement it will, in no long time, work a passage through a wall of brick. M. Sonnini considers the jerboa as constituting a link between quadrupeds and birds. The beginning of the connection between the former and the latter is considered by Shaw as formed by the jerboa, and the last link as completed in the bat. In the sand and ruins about Alexandria the jerboa is very frequently to be found. It is, however, extremely shy, retiring on the slightest alarm to its habitation, and the common mode of destroying them among the Arabs, as related by Sonnini, is by stopping up all the accesses to their residence but one, and watching their egress at that. In Egypt they are used as food. M. Sonnini kept several in a cage for a considerable time, feeding them on walnuts and other fruits. They appeared extremely fond of basking in the sun, and indeed, in the sun-shine, were often extremely alert and playful. They were mild in their dispositions even in feeding, shewing no tendency to quarrelsomeness, or ferocity; but, on the other hand, they exhibited little or no susceptibility of gratitude or attachment, of joy or fear, and their manner were characterized by a cold and stupid indifference. See Mammalia, Plate IX. fig. 5.

D. Canadensis, or the Canada rat. This is the smallest species of the jerboa, being about the size of a mouse. General Davies had several specimens in his possession, and his account of this curious animal is to be found in the fourth volume of the transactions of the Linnæan Society. In company with several other gentlemen, the General caught one of these jerboas in a large field, after an hour's chase, during which the little creature took the extraordinary leaps of from three to five yards in almost uninterrupted successions, sinking, however, at length, under fatigue from such wonderful exertions. Its food could not be ascertained by the General, who offered it a great variety, no article of which it appeared at all disposed to touch, and the day after its seizure it died, overwhelmed, probably, by its extreme efforts to escape from its pursuers. It is sometimes found dormant, and in this state, probably, passes the winter in the rigorous climate of Canada. A specimen of it in this state was

Fig.1. **Didelphis** *maculata: spotted opossum _ Fig.2.* **D.volans:** *flying opossum _ Fig.3.* D.*gigantea kanguroo Fig.4.* D.*tridactyla: kanguroo rat _ Fig.5.* **Dipus** *jaculus: common jerboa _ Fig.6.* D.*canadensis: canada jerboa.*

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brought to the General, after having been found by a labourer, whose spade struck against a substance about the size of a cricket ball, which, on examination, was found to inclose a jerboa, completely rolled up, and in a state of torpor. The ball was found about a foot and a half under the surface of the ground, was perfectly smooth internally, and about an inch in thickness. This case, which was composed of clay, was somewhat mutilated by the accidental blow of the workman, but was deposited by the General, with its contents, in his room, in a small box supplied with some cotton, in hopes that, as the warm season advanced, the animal would revive from its suspended vitality. This hope, however, was not gratified. As the jerboa is not seen in Canada from October till May, it may be concluded that it passes the winter in this curious envelope. See Mammalia, Plate IX. fig. 6.

DIRCA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Vepreculæ. Thymelææ, Jussieu. Essential character: calyx none; corolla tubulous, with an obscure border; stamina longer than the tube; berry one-seeded. There is only one species, *viz.* D. palustris, marsh-leatherwood, a native of North America.

DIRECTION, in mechanics, signifies the line or path of a body's motion, along which it endeavours to proceed, according to the force impressed upon it.

DIRECTOR, in commercial polity, a person who has the management of the affairs of a trading company: thus we say, the directors of the India company, South-sea company, &c.

DIRECTOR, in surgery, a grooved probe, to direct the edge of the knife or scissars, in opening sinuses, or fistulæ, that by this means the subjacent vessels, nerves, and tendons may remain unhurt.

DIRGE, in music, a solemn and mournful composition performed at funeral processions. The dirge was in very general use with the ancients, and was numerously filled both by voices and instruments.

DIRIGENT, or *directrix*, a term in geometry, signifying the line of motion, along which the describent line or surface is carried in the genesis of any plane or solid figure.

DIS, an inseparable particle prefixed to divers words, the effect whereof is either to give them a signification contrary to what the simple words have, as *disoblige*, *disobey*, &c. or to signify a separation, detachment, &c. as *disposing*, *distributing*, &c.

DISA, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: spathe one-valved; petals three, two-parted, gibbous at the base. There are four species. These are all natives of the Cape.

DISABILITY, a incapacity in a man to inherit or take a benefit which otherwise he might have done, which may happen four ways; by the act of the ancestor, by the act of the party, by the act of law, and by the act of God. 1. Disability by the act of the ancestor; as, if a man be attainted of treason or felony; by this attainder his blood is corrupt, and himself and his children disabled to inherit. 2. Disability by the act of the party himself; as if one make a feoffment to another who then is sole, upon condition that he shall enfeoff a third before marriage, and before the feoffment made, the feoffee takes a wife; he hath by that disabled himself to perform the condition according to the trust reposed in him, and therefore the feoffer may enter and oust him. 3. Disability by act of law, is when a man by the sole act of the law is disabled, as an alien born, &c. 4. Disability by the act of God, is where a person is of non-sane memory, and in cases of idiocy, &c. But it is a maxim in our law, that a man of full age shall never be received to disable his own person.

DISANDRA, in botany, a genus of the Heptandria Monogynia class and order. Natural order of Pediculares, Jussieu. Essential character: calyx seven-leaved; corolla seven-parted, flat; capsule two-celled. There are two species, *viz.* D. prostrata, trailing disandria, and D. africana; the former a native of Madeira, the latter of Africa.

DISC, in astronomy, the body and face of the sun and moon, such as it appears to us on the earth; or the body or face of the earth, such as it appears to a spectator in the moon, &c. The disc in eclipses is supposed to be divided into twelve equal parts, called digits: in a total eclipse of the luminaries, the whole disc is obscured; in a partial eclipse, only a part thereof.

DISCORD, in music, a dissonant and inharmonious combination of sounds, so called in opposition to the concord. Among various other discords are those formed by the union of the fifth with the sixth, the fourth with the fifth, the seventh with the

eight, and the third with the ninth and seventh.

DISCOUNT, a compensation for the advance of money which is not due till after a certain period. The person advancing the money, had he retained it, might have made in the given time a certain rate of interest; therefore if he advances it for the use of another, it is equitable that he should be allowed the same gain as he would have made by retaining it in his own hands during the time for which it is lent. Thus, if a person is entitled to 100*l.* at the end of a year, and has occasion for the money immediately, the sum that ought to be given as an equivalent thereto, allowing 5 per cent interest, is 95*l.* 4*s.* 9¼*d.*; for the discount of 4*l.* 15*s.* 2¾*d.* which is then retained, will, if improved at 5 per cent interest, amount at the end of a year to 5*l.* and consequently the lender having then 105*l.* will have made the same gain as he would have made by retaining the money. This is the true principle of discount, according to which the tables published by Mr. Smart are computed; but in commercial transactions, the general mode is, to deduct from the sum to be discounted, the simple interest on that sum for the time for which it is advanced. Thus, if 100*l.* is payable at the end of six months, the discount deducted is 2*l.* 10*s.* being the half of a year's interest; or, if 100*l.* is payable at the end of one month, the discount deducted is 8*s.* 4*d.* being the twelfth part of a year's interest. By this means, although the legal rate of interest to be received for money lent is restricted to 5 per cent, the person who employs his money in discounting, makes a greater rate of interest, and the shorter the periods are for which he discounts, the greater his annual gains. In discounting bills of exchange, the days of grace are included in the time the bill has to run, the discount being calculated to the day on which the money is receivable.

Discounting of bills of exchange is one of the modes in which bankers employ the money placed in their hands: they generally discount at 5 per cent, but in time of peace, when the current prices of the public funds are high, they are often willing to discount at 4½ or 4 per cent. The bank of England, and other public banks, likewise employ very considerable sums in discounting: the Bank of England never discount any bills which have more than 65 days to run.

Discount is likewise used for certain customary allowances made by manufacturers and wholesale dealers, to those who purchase goods of them in order to sell retail. In some trades this discount is merely in lieu of credit, in others it is made on all goods sold, whether for immediate payment, or on credit; and is very different on different articles, being on some not more than 1 or 2 per cent. while on others it amounts to 50, and sometimes more than 60 per cent.

DISCRETE, or *Disjunct Proportion*, is when the ratio of two or more pairs of numbers or quantities is the same, but there is not the same proportion between all the four numbers. Thus, if the numbers 3 : 6 :: 8 : 16 be considered, the ratio between 3 : 6 is the same as that between 8 : 16, and therefore the numbers are proportional; but it is only discretely or disjunctly, for 3 is not to 6 as 6 to 8; that is, the proportion is broken off between 8 and 3, and is not continued as in the following continual proportionals, 3 : 6 :: 12 : 24.

DISCRETE *quantity*, such as is not continuous and joined together. Such is a number whose parts being distinct units, cannot be united into one continuum; for in a continuum, there are no actual determinate parts before division, but they are potentially infinite.

DISCUSSION, in matters of literature, signifies the clear treating or handling of any particular point, or problem, so as to shake off the difficulties with which it is embarrassed: thus we say, such a point was well discussed, when it was well treated of and cleared up.

DISEASE, in medicine, the state of a living body, wherein it is deprived of the exercise of any of its functions, whether vital, natural, or animal. See MEDICINE.

DISGUISE, a counterfeit habit. Persons doing unlawful acts in disguise, are by our statutes sometimes subjected to great penalties, and even declared felons. Thus by an act, commonly called the black act, persons appearing disguised and armed in a forest, or grounds inclosed, or hunting deer, or robbing a warren or a fish-pond, are declared felons.

DISH, among miners, denotes a wooden measure, wherein they are obliged to measure their ore: it is kept by the barmaster, and contains about 672 solid inches.

DISJUNCTIVE *proposition*, in logic, is that where of several predicates we affirm one necessarily to belong to the subject to the exclusion of all the rest, but leave that par-

ticular one undetermined. Such is the major of the following disjunctive syllogism.

The world is either self-existent, or the work of some finite, or of some infinite being.

But it is not self-existent, nor the work of a finite being.

Therefore it is the work of an infinite being.

DISPATCH, a letter sent abroad by a courier on some affair of state, or other matter of importance. The business of dispatches lies upon the ministers of state and their clerks.

DISPENSARY, a charitable institution, very common in London and some other large towns of Britain. They are supported by voluntary subscriptions, and each has one or more physicians, surgeons, and apothecaries, who attend, or ought to attend at stated times, in order to prescribe for the poor, and if necessary to visit them at their own habitations. The poor are supplied with medicines gratis. Where these institutions are managed with care they are of the utmost importance to society, it being unquestionably more for the comfort of the sick to be attended at their own houses, than to be dragged from their families to an hospital.

DISPENSATORY, denotes a book containing the method of preparing the various kinds of medicines used in pharmacy. Such are the London, Edinburgh, and Dublin pharmacopæias.

DISPLAYED, in heraldry, is understood of the position of an eagle, or any other bird when it is erect, with its wings expanded or spread forth.

DISPOSITION, in rhetoric, the placing words in such an order as contributes most to the beauty, and sometimes even to the strength of a discourse. See RHETORIC.

DISSECTION, in anatomy, the cutting up a body with a view of examining the structure and use of the parts. See ANATOMY.

DISSEISIN, is a wrongful putting out of him that is seized of the freehold, which may be effected either in corporeal inheritances, or incorporeal. Disseisin of things corporeal: as of houses and lands must be by entry and actual dispossession of the freehold. Disseisin of incorporeal hereditaments, cannot be an actual dispossession, for the subject itself, is neither capable of actual bodily possession, or dispossession, but is only at the election and choice of the party injured, if, for the sake of more easily trying the right, he is pleased to suppose himself disseised. And so also even in corporeal hereditaments, a man may frequently suppose himself to be disseised, when he is not so in fact, for the sake of entitling himself to the more easy and commodious remedy of an assize of novel disseisin, instead of being driven to the more tedious process of a writ of entry.

DISSENTERS, in church history, are a numerous body of people in this country, who made their first appearance in Queen Elizabeth's time, when, on account of the extraordinary purity, which they proposed in religious worship and conduct, they were reproached with the name of Puritans. They increased in numbers by the act of uniformity, which took place on Bartholemew's day 1682, in the reign of Charles II. By this act 2000 ministers of the establishment, refusing to conform to certain conditions, were obliged to quit their livings, and hence arose the name of Non-conformists. The descendants of these are known by the name of Protestant Dissenters: they may be considered in general as divided into the denominations of Presbyterians, Independents, and Baptists, which see.

The principles on which Dissenters separate from the Church of England, are the same with those on which she separates herself from the Church of Rome; these are the right of private judgment; liberty of conscience; and the perfection of scripture as a christian's only rule of faith and practice. Dr. Taylor, speaking of the Dissenters who were ejected in 1662, says, "They were men prepared to lose all, and to suffer martyrdom itself, and who actually resigned their livings, rather than desert the cause of civil and religious liberty, which together with serious religion, would, I am persuaded, have sunk to a very low ebb, had it not been for the noble stand, which these worthies made against imposition upon conscience, prophaneness, and arbitrary power. They had the best education England could afford, most of them were excellent scholars, judicious divines, pious, faithful, and laborious ministers, undaunted and courageous in their master's work, standing close to their people in the worst times, diligent in their studies, solid, affectionate, powerful, awakening preachers, aiming at the advancement of real vital religion in the hearts and lives of men, which flourished wherever they had influence.

Dissenters, before the revolution, many

statutes were in force against Dissenters, but by William I. stat. 1. cap. 18. commonly called the "Toleration Act," it is enacted, that none of the acts made against persons dissenting from the Church of England, (except the Test Acts 25 Charles II. cap. 2. and 30 Charles II. stat. 2. cap. 1.) shall extend to any person dissenting from the Church of England, who shall at the general sessions of the peace, to be held for the county or place where such person shall live, take the oaths of allegiance and supremacy, and subscribe the declaration against popery, of which the court shall keep a register; and no officer shall take more than 6d. for registering the same, and 6d. for a certificate thereof signed by such officer. Provided that the place of meeting be certified to the bishop of the diocese, or to the archdeacon of the archdeaconry, or to the justices of the peace at the general or quarter sessions; and the register or clerk of the peace, shall register on record the same, and give certificate thereof to any one who shall demand the same; for which no greater fee than 6d. shall be taken: and provided that during the time of meeting, the doors shall not be locked, barred, or bolted.

Dissenters chosen to any parochial or ward offices, and scrupling to take the oaths, may execute the office by deputy, who shall comply with the law in this behalf. But it seems they are not subject to fine, on refusing to serve corporation offices; for they may object to the validity of their election, on the ground of their own nonconformity.

DISSONANCE, in music, the effect which results from the unison of two sounds not in accord with each other.

DISSYLLABLE, among grammarians, a word consisting only of two syllables: such as nature, science, &c.

DISTAFF, an instrument about which flax is tied in order to be spun.

DISTANCE, in general, an interval between two things, either with regard to time or place. Dr. Berkely, in his essay on vision, maintains that distance cannot of itself and immediately be seen, for distance being a line directed endwise to the eye, it projects only one point in the fund of the eye, which point remains invariably the same, whether the distance be longer or shorter. But Mr. M'Laurin observes, that the distance here spoken of, is distance from the eye; and that what is said of it must not be applied to distance in general. The apparent distance of two stars is capable of the same variations as any other quantity or magnitude. Visible magnitudes consist of parts into which they may be resolved as well as tangible magnitudes, and the proportions of the former may be assigned as well as those of the latter; so that it is going too far to tell us, that visible magnitudes are no more to be accounted the object of geometry than words; and that the ideas of space, and things placed at a distance, are not, strictly speaking, the object of sight; and are not otherwise perceived by the eye than by the ear.

DISTANCE, in navigation, the number of minutes or leagues a ship has sailed from any given place or point.

DISTANCE, in astronomy. The distance of the sun, planets, and comets, is only found from their parallax, as it cannot be found either by eclipses or their different phases: for from the theory of the motions of the earth and planets we know, at any time, the proportion of the distances of the sun and planets from us; and the horizontal parallaxes are in a reciprocal proportion to these distances. See ASTRONOMY.

DISTANCE *of the eye*, in perspective, is a line drawn from the eye to the principal point. See PERSPECTIVE.

DISTANCES *accessible*, in geometry, are such as may be measured by the chain, &c.

DISTANCES *inaccessible*, are such as cannot be measured by the chain, &c. by reason of some river, or the like, which obstructs our passing from one object to another. See MENSURATION.

DISTICH, a couplet of verses making a complete sense. Thus hexameter and pentameter verses are disposed in distichs.

DISTILLATION, a chemical process, which consists in separating bodies which are volatile, from those which are more fixed, by the application of heat. All bodies which are susceptible of the elastic or vaporous form, at the same time that they are not decomposed, or otherwise changed in their properties, are capable of being separated from other matter by distillation.

The process employed for distilling liquid bodies from other matter, is simply called distillation; that, on the contrary, used to separate solid bodies, by giving them the elastic form, is termed sublimation.

The apparatus employed for the first process are of several varieties, suited to the nature of the volatile body. That employed for the distillation of water, alco-

hol, and the various essential oils, is called a still. It is chiefly made of copper, and ought to be so constructed, that as great an evaporable surface as possible may be exposed. Those employed in the Scotch distilleries are in the form of an erect cone, the base of which is about four times the altitude. The vapour which comes from the still, is condensed in two ways. The first is the oldest and most simple method, but not the most effective. The head, or capital of the still is so formed, as to have a vessel or cavity on the outside, containing cold water; the inside is in the form of a cone, and sometimes of a dome, round the base of which is placed a channel, terminating in an inclined beak, or tube, to convey the liquid arising from the condensed vapour. When the vapour rises up against the conical, or dome like surface, the external water causes it instantly to condense, and the drops run down the surface into the channel, from whence they pass into the delivering tube, and thence into the receiver. The other method of condensation, consists in letting the vapour pass through a spiral tube, fitted into the inside of a tub, which is filled with cold water, and so contrived, that the product of the distillation shall have no communication with the external water. This tub, which is called a worm tub, should be supplied with cold water at the bottom, while the warm water, caused by the condensation of the vapour, should be made to run off at the top.

The apparatus employed for distilling bodies more easily condensible, consist of two parts, one called the retort, containing the substance to be distilled, and the other the receiver, because it receives the substance raised from the retort. In the distillation of bodies which afford permanent gases as well as condensible matters, in addition to the receiver, a number of connected vessels are employed, constituting what, from its inventor is called a Woulfe's apparatus, in which, what is not condensed, or absorbed in the first bottle, passes forward to the second, and so on to the third and fourth, till at length the absolutely incondensable part is received into a vessel called a gasometer. Before the invention of this apparatus, this kind of distillation was attended with great danger, both to the apparatus and the operator; the receiver being very liable to burst, and the fumes being intolerably suffocating. Both these inconveniences are completely obviated by the invention of the Woulfe's apparatus. Sometimes an apparatus called an alembic is used for distillation; it is generally of glass, and is used for experiments in the small way; it consists of a bottle holding the substance to be distilled, having a dome like head, furnished with a channel similar to that of the common stile; indeed it differs only from it, in not having cold water on the outside. There are various modes of applying heat in distillation, depending upon the nature of the apparatus employed, as well as upon the substance to be distilled. The common still, which being of metal, is immediately exposed to the naked fire, since from its tenacity, and its property of conducting heat with facility, it is not liable to crack, which is not the case with glass and earthen ware. If the vessel holding the substance to be distilled, be of the latter kind, it is essential to apply the heat very gradually and uniformly, and after the process, to suffer it to cool in a similar manner. This is effected in different ways; the most common of which is the sand bath, which consists of a vessel of iron filled with fine dry sand. The retort, or other vessel, is imbedded in the sand previous to the application of the fire; the inferior conducting power of the sand does not allow the heat to approach the retort, but in that gradual way, which will insure its safety from cracking. The heat must also be more uniform, since any sudden increase, or diminution of the fire, will not so immediately affect the retort.

In experiments in the small way, the lamp will answer every purpose of the sand bath, as the sliding rest containing the retort, admits of its being placed at any given distance from the flame. In addition to this, the Argand lamp can be adjusted by the rack, to almost any degree of intensity below its maximum. Another method of defending the retort from the too rapid effect of the heat, consists in coating the outside with a mixture of horse-dung and clay, or loam. When a limited degree of heat is required in distillation, recourse is had to a bath of some liquid, whose boiling point will give the degree of heat required, such as water, oil, or mercury. If, for instance, it were required to separate any substance from water more volatile than that liquid, it would be necessary to employ a water-bath, in which to place the retort, keeping the water in the bath below its boiling point.

The laws of distillation, however, are so modified by other circumstances, as to render some of the preceding rules in some measure exceptionable. If the different bodies subjected to distillation had no chemical affinity for each other, it is probable that each substance would put on its elastic form, only at that temperature at which it would, in a separate state, be converted into vapour. But we frequently find, that one volatile substance will carry along with it other bodies of considerable fixity. From the affinity which water has to air, we observe the evaporation of the former to take place at all temperatures below its boiling point; and though it has been thought that water might be freed from saline matter by distillation, it is found by experiment, that several salts are carried over along with the vapour of the water, which in their dry state would undergo decomposition before they would be induced to assume the elastic form. Hence water, by the common mode of distillation, cannot be rendered pure. From the circumstance, that the air is capable of raising water and other liquids at a low temperature, we are enabled to perform the distillation of such liquids, by making the slightest degree of difference of temperature between the retort and the receiver. Water and alcohol may be obtained perfectly pure, by placing the retort in the temperature of 100°, and the receiver in that of 50° of Farenheit scale.

The salts most liable to rise with water, in distillation, are carbonate ammonia, muriates of lime and magnesia, and nitrate of soda. Indeed this tendency appears to be directly, as the solubility of the salt, or rather as its deliquiescent property, which is as its affinity for water.

DISTRESS, in law, is the taking of a personal chattel, out of the possession of the wrong doer, into the custody of the person who is injured, to procure a satisfaction for the wrong committed. It is of two kinds: cattle for trespassing and doing damage, or for non-payment of rent or other duties. But the most usual injury for which a distress may be taken, is that of non-payment of rent.

DISTRIBUTION *of intestate's effects*, after payment of the debts of the deceased, is to be made according to the manner following: one third shall go to the widow of the intestate, and the residue in equal proportions to his children; or if dead to their representatives, that is, their lineal descendants: if there be no children, or legal representatives, then a moiety shall go to the widow, and a moiety to the next kindred in equal degree, or their representatives: if no widow, the whole shall go to the children: if neither widow nor child, the whole shall be distributed amongst the next kindred in equal degree, and their representatives: but no representatives are admitted among collaterals, farther than the children of the intestate's brothers and sisters. The father succeeds to the whole personal effects of his children if they die intestate and without issue; but if the father be dead, and the mother survive, she shall only come in for a share equally with each of the remaining children.

DITTO, usually written D°, in books of accounts, an Italian word, signifying the aforementioned.

DIVAN, a council chamber, or court of justice, among the eastern nations, particularly the Turks.

DIVER. See COLYMBUS.

DIVERGENT *rays*, in optics, are those which going from a point of the visible object, are dispersed, and continually depart one from another, in proportion as they are removed from the object: in which sense it is opposed to convergent. Concave glasses render the rays divergent, and convex ones convergent. Concave mirrors make the rays converge, and convex ones make them diverge.

DIVERSION, in military affairs, is when an enemy is attacked in one place where they are weak and unprovided, in order to draw off their forces from another place where they have made, or intend to make, an eruption. Thus the Romans had no other way in their power of driving Hannibal out of Italy but by making a diversion in attacking Carthage.

DIVIDEND. See ARITHMETIC.

DIVIDEND, in commerce, the proportion of profits which the members of a society, or public company, receive at stated periods, according to the share they possess in the capital or common stock of the concern.

The term is likewise generally applied to the annual interest paid by goverment on the various public debts, although this is either a terminable or perpetual annuity, and in no respect a division of profits. In this sense, the order by which stockholders receive their interest is called a dividend warrant, and the portions of interest un-

received are denominated unclaimed dividends.

The amount of unclaimed dividends remaining in the hands of the Bank of England, previous to the year 1750, seldom exceeded 50,000*l.*; its increase since that period will appear from the following extract from an account laid before the House of Commons.

	£.	s.	d.
On July, 5, 1759......	102,075	4	$11\frac{3}{4}$
———— 1769......	227,928	6	$2\frac{1}{4}$
———— 1779......	314,885	8	$3\frac{1}{4}$
———— 1789......	547,366	16	$6\frac{3}{4}$

In 1791, an act was passed authorising the bank to advance out of the unclaimed dividends in their hands 500,000*l.* for the public service; with a provision that if the sum in their hands should be reduced unde 600,000*l.* the difference should be repaid them. In consequence of the publication of the names of the proprietors of the dividends then unclaimed, a considerable part of them were received, and the sum advanced to government thus became only 376,739*l.* The amount of unclaimed dividends has accumulated considerably, being

On April 1, 1806	£1,235,265
—— July 1	1,003,599
—— October 1	1,067,778
—— January 1, 1807......	1,019,336

In consequence of this great increase, the bank, in 1808, advanced the further sum of 500,000*l.* for the public service, on condition that the balance in their hands, on this account, should never be reduced below 100,000*l.*

Dividend, in the university, signifies that part or share which every one of the fellows equally divide among themselves of their yearly stipend.

DIVINATION, the knowledge of things obscure, or future, which cannot be attained by any natural means.

DIVINE, something relating to God.

DIVING, the art of descending under water, to considerable depths, and abiding there a competent time. The uses of diving are considerable, particularly in fishing for pearls, corals, sponges, wrecks of ships, &c. See Pearl, &c.

There have been various engines contrived to render the business of diving safe and easy; the great point is to furnish the diver with fresh air, without which he must either make but a short stay, or perish. Those who dive for sponges in the Mediterranean, carry down sponges dipt in oil in their mouths, but considering the small quantity of air that can be contained in the pores of a sponge, and how much that little will be contracted by the pressure of the incumbent air, such a supply cannot subsist a diver long, since a gallon of air is not fit for respiration above a minute.

Diving *bell.* A diving bell is most conveniently made in form of a truncated cone, the smaller end being closed, and the larger opened. It is to be poised with lead, and so suspended, that the vessel may sink full of air, and with its open base downward, and as nearly as may be in a situation parallel to the horizon, so as to close with the surface of the water all at once. The diver sitting under this, sinks down with the included air to the depth desired; and if the cavity of the vessel can contain a tun of water, a single man may remain a full hour without much inconvenience at five or six fathoms deep; but the lower he goes the included air contracts itself according to the weight of the water which compresses it, so that at thirty-three feet deep the bell becomes half full of water, the pressure of the incumbent water being then equal to that of the atmosphere, and at all other depths the space occupied by the compressed air in the upper part of the bell will be to the under part of its capacity filled with water, as thirty-three feet to the surface of the water in the bell below the common surface, and this condensed air being taken in with the breath, soon accommodates itself to the existing circumstances, so as to have no ill effect, provided the bell is admitted to descend slowly, but the greatest inconvenience of this engine, is, that the water entering it, contracts the bulk of air into so small a compass, that it soon heats and becomes unfit for respiration, so that there is a necessity for its being drawn up to recruit it, besides the uncomfortable situation of the diver who must be almost covered with water.

To obviate these difficulties of the diving bell, Dr. Halley, to whom we owe the preceding account, contrived a farther apparatus, whereby, not only to recruit the air from time to time, but also to keep the water wholly out of the machine at any depth. This bell was made of wood, containing about sixty cubic feet in its concavity, and was the form of a truncated cone, whose diameter at the top was three feet, and at the bottom five. It was so loaded with lead that it would go down in a perpendicular direction and no other. In the top was a window to let in light, and likewise

a cock to let out the hot air that had been breathed; and below, about a yard under the bell, was a stage suspended by three ropes, each of which was charged with about one hundred weight to keep it steady. To supply air, the bell had a couple of barrels so cased with lead as to sink when empty, each having a bung-hole in its lowest part to let in the water as the air in them condensed on their descent, and to let it out again when they were drawn up full from below. To a hole in the uppermost part of these was fixed a leathern trunk or hose, long enough to fall below the bung-hole, and kept down by a weight in such a way that the air in the upper part of the barrels could not escape, unless the lower ends of these hose were first lifted up. These air barrels were made to rise and fall like two buckets in a well, by means of these barrels fresh air was continually supplied from above, and it was done with so much ease, that two men with less than half their strength could perform all the labour required. By an additional contrivance it was found practicable, for a diver to go out of the engine, to some distance from it, the air being conveyed to him in a continuable stream by small flexible pipes.

A great improvement in the diving bell was made by the late Mr. Spalding, of Edinburgh. This construction seems designed to remedy some inconveniences of Dr. Halley, which are very evident, and of a very dangerous tendency; these are, 1. by Dr. Halley's constructions, the sinking or rising of the bell depends on the people who are at the surface of the water, as the bell when in the water has a very considerable weight, the raising it not only requires a great deal of labour, but there is a possibility of the rope breaking, by which it is raised, and thus every person in the bell would inevitably perish: 2. As there are in many parts of the sea rocks which lay at a considerable depth, the figure of which cannot possibly be perceived from above, there is danger that some of their ragged prominences, may catch hold of one of the edges of the bell in its descent, and thus overset it before any signal can be given to those above, which would infallibly be attended with the destruction of the people in the bell; and as it must always be unknown before trial what kind of a bottom the sea has in any place, it is plain, that without some contrivance to obviate this last danger, the descent in Dr. Halley's diving bell is not at all eligible.

How these inconveniencies are remedied by Mr. Spalding's new contrivance, will be easily understood from the following descriptions, A B C D fig. 3, represents a section of the bell which is made of wood, *e e* are iron hooks, by means of which it is suspended by ropes Q B F *e* and Q A E *e* and Q S as expressed in the figure *c c* are iron hooks, to which are appended leaden weights, that keep the mouth of the bell always parallel to the surface of the water, whether the machine taken altogether is lighter or heavier than an equal bulk of water. By these weights alone, however, the bell would not sink, another is therefore added, represented at L, and which can be raised or lowered at pleasure, by means of a rope passing over the pulley *a*, and fastened to the sides of the bell M. As the bell descends, this weight, called by Mr. Spalding the balance weight, hangs down a considerable way below the mouth of the bell. In case the edge of the bell is caught by any obstacle, the balance weight is immediately lowered down, so that it may rest upon the bottom, by this means the bell is lightened, so that all danger of oversetting is removed, for being lighter without the balance weight than an equal bulk of water, it is evident that the bell will rise as far as the length of the rope affixed to the balance weight will allow it. This weight therefore will serve as a kind of anchor to keep the bell at any particular depth which the divers may think necessary, or by pulling it quite up, the descent may be continued to the very bottom.

By another very ingenious contrivance, Mr. Spalding rendered it possible for the divers to raise the bell with all the weights appended to it, even to the surface, or to stop at any particular depth as they think proper; and thus they could still be safe, even though the rope designed for pulling up the bell was broken; for this purpose, the bell is divided into two cavities, both of which are made as tight as possible; just above the second bottom, EF, are small slits on the sides of the bell through which the water entering as the bell descends, displaces the air originally contained in its cavity, which flies out at the upper orifice of the cock H. When this is done, the divers turn the handle which stops the cock, so that if any more air was to get into the cavity A E F B, it could no longer be discharged through the orifice H as before. When this cavity is full of water, the bell sinks, but when a considerable quantity of

air is admitted, it rises. If therefore the divers have a mind to raise themselves, they turn the small cock, by which a communication is made between the upper and under cavities of the bell; the consequence of this is, that a quantity of air immediately enters the upper cavity, forces out a quantity of water contained in it, and thus renders the bell lighter by the whole weight of the water which is displaced thus. If a certain quantity of air is admitted into the upper cavity, the bell will descend very slowly; if a greater quantity, it will neither ascend nor descend, but remain stationary; and if a larger quantity of air be still admitted, it will rise to the top. It is to be observed, however, that the air which is thus let out into the upper cavity, must be immediately replaced from the air barrel, and the air is to be let out very slowly, or the bell will rise to the top with so great velocity, that the divers will be in danger of being shaken out of their seats; but by following these directions, every possible accident may be prevented, and people may descend to very great depth without the least apprehension of danger, the bell also becomes so easily manageable in the water that it may be conducted from one place to another by a small boat with the greatest ease, and with perfect safety to those who are in it.

Instead of wooden seats, used by Dr. Halley, Mr. Spalding made use of ropes suspended by hooks *b*, *b*, *b*, and on these ropes the divers may sit without any inconvenience, there are two windows made of thick strong glass for admitting light to the divers; N represents an air cask with its tackle, and C P the flexible pipe through which the air is admitted to the bell, in the ascent and descent of this cask, the pipe is kept down by a small appended weight, as in Dr. Halley's machine; R is a small cock by which the hot air is discharged as often as it becomes troublesome.

Mr. Spalding is of opinion, that one air barrel, capable of containing thirty gallons, is sufficient for an ordinary machine.

In fig. 1 and 2, are shewn representations of a frame for supporting a diving bell, and transporting it from place to place upon the water. Fig. 1, is a side elevation, and fig. 2, a section of it. The same letters refer to both figures. A B, fig. 2, are sections of two barges, such as are used upon the Thames, at London: D E F, is a frame laying across the barges, and supporting a beam, G, from which hangs a strong block for the rope by which the bell, H, is suspended; the other end of the rope goes round a windlass, *a*, with a rachet wheel and click to raise and lower the bell as occasion requires: *b d* are smaller blocks, for the ropes to draw up the air barrels; *e f* are rollers, turned by winches, fixed on the opposite barge to the windlass, *a*; the ropes are wound round these rollers in contrary directions, and the winches come close together, so that one man can turn them both at once, and when one rope descends, the other ascends, so as to give a constant supply of air to the divers under the bell, H. When the divers wish to come up, they give a signal to that purpose, and the windlass is turned by men until the bottom of the bell is brought above water; a small boat or raft is rowed under the bell to take the divers out: the same method is to be used to get them in, and this will be done without wetting them, or any other inconvenience. Several small bells of very different tones should be fixed to the beam G, and strings fastened to them should go into the bell for the divers to ring, as signals to the workmen in the barges above. The barges should be well secured together by cross beams.

Several other machines have been contrived to answer the purposes of the diving-bell; one of which, fig. 4, was invented in 1753, by —— Rowe, Esq. and published in the Universal Magazine.

The engine is a trunk, or hollow vessel, of copper or brass, of sufficient strength to resist the pressures of deep waters, and dimensions to contain the body of a man, supposed to enter therein feet foremost at *t*, bent at the bearing of his knees at *l*, for the more convenient going between rocks and great stones; at *k*, and on the other side, are holes for his arms to pass through, and a glass for his sight at *n*. *h* represents a sleeve made of soft leather, lined with fine cloth, exactly to fit the diver, and fastened to the body of the engine at *k*, where the arms come through; which is likewise defended by a soft quilting, to prevent the arms from being hurt by pressure, and the sleeves from being thrust into the engine; *d d* represents a cover to fit the head of the engine, fastened down with screws, and leather between the borders, so as to prevent leaking in any depth of water; *a b* represents a plate of lead, to be fastened before the engine, in a straight line, passing between the arms, not only as a proper weight to sink the engine, but as a balance thereto; whereby the diver will always be

kept in a proper posture for working, and the more so by means of a block, or cradle, supposed to be fastened over the lead, by which means the diver has not only the power of handling what is at the bottom; but may at any time rest his arms from work; *g* is the engine-rope by which it is let down and hauled up again from the bottom; *z y u* is called the life-line, with a knot at *y*, so as the handle at *z* may always remain at a due distance for the diver to take hold thereof, in order to give any notice to the persons above, as, by agreement, by giving a certain number of pulls, or sudden twitches, which is immediately felt by the person that holds the line. The diver can tarry under water at least half an hour at one time, without the help of pipes, or any other air than what the engine contains. At *i* and *w* are two brass screw caps, or plugs, both which are to be opened as soon as the diver gets from the bottom to the water's surface, in order to give him fresh air by help of a pair of bellows blowing at the latter; at which, when the engine leaks, we likewise pump out the water. In deep water the diver is forced to make use of a saddle on his back, with a ridge touching the upper part of the engine, whereby he can keep his arms at a due distance out of the engine, which otherwise would be thrust in by the column of water pressing thereon equal to the weight thereof.

The subject of submarine navigation was largely and pleasantly discanted upon by Mersennus, in his " Tractatus de Magnetis Proprietatibus," and Bishop Wilkins has given a chapter at some length on the subject, in his " Mathematical Magick," (ed. 1648) where he affirms that Cornelius Dreble has proved, beyond all question, that the contrivance is feasible, by the experiments he made in England. The chapter of Wilkins is entertaining for a sort of visionary facility with which he removes the difficulties, and enumerates the benefits of these submarine enterprizes. For letting out and taking in such things as the nature of the voyage may require, he recommends bags, or flexible tubes, somewhat resembling the scupper bags of ships. The progressive motion may, he observes, be produced by fins or oars, which will operate with ease when the vessel is truly equipoised; and if swiftness should not be obtained, he supposes the observations and discoveries to be made at the bottom of the sea would abundantly recompense for the defect. The greatest difficulty, in his apprehension, would be the necessity of renovating the air for respiration and combustion; for remedying which, besides the probability that custom may render men capable of living in air of inferior purity, he has several philosophical views and projects. The conveniences and advantages he enumerates are, 1. Privacy; as a man may thus go to any part of the world invisibly, without being discovered or prevented. 2. Safety from the uncertainty of tides and tempests, that vex the surface; from pirates and robbers; and from the ices that so much endanger other voyages towards the poles. 3. It may be of use to undermine and blow up a navy of enemies: 4. Or to relieve a blockaded place. 5. And as the prospect enlarges in the mind of our author, he proceeds to contemplate the unspeakable benefit of submarine discoveries. Experiments on the ascent and descent of submerged bodies; the exploration of the deep caverns and passages, and the waters of the ocean; observations on the nature and kinds of fishes, with allurements, artifices, and treacheries which may successfully be practised during so familiar a residence in their territories; the food and oil they may afford; the probability of fresh springs for a supply of water at the bottom of the sea; the facility of recovering submarine treasures, whether lost or naturally produced beneath the ocean; and last of all he adds, that

" All kinds of arts and manufactures may be exercised in this vessel. The observation made by it may be both written, and, if need were, printed here likewise. Several colonies may thus inhabit, having their children born and bred up without the knowledge of land, who could not chuse but be amazed with strange conceits upon the discovery of this upper world."

The only modern instance of actual submarine navigation is that of Mr. Bushnel, recorded in the Transactions of the American Society, Vol. IV. The external shape of his vessel bore some resemblance to two upper tortoise shells of equal size joined together; the place of entrance into the vessel being represented by the opening made by the swell of the shells at the head of the animal. The inside was capable of containing the operator, and air sufficient to support him thirty minutes without receiving fresh air. At the bottom, opposite the entrance, was fixed a quantity of lead for ballast. At one edge, which was directly before the operator, who sat upright, was an oar for rowing forwards and backwards. At

the other edge was a rudder for steering. An aperture at the bottom, with its valve, was designed to admit water for the purpose of descending; and two brass forcing-pumps served to eject the water within when necessary for ascending. At the top there was likewise an oar for ascending or descending, or continuing at any particular depth; a water-guage or barometer determined the depth of descent, a compass directed the course, and a ventilator within supplied the vessel with fresh air when on the surface.

The entrance into the vessel was elliptical, and so small as barely to admit a person. This entrance was surrounded with a broad elliptical iron band, the lower end of which was let into the wood, of which the body of the vessel was made, in such a manner, as to give its utmost support to the body of the vessel against the pressure of the water. Above the upper edge of this iron band there was a brass crown or cover, resembling a hat with its crown and brim, which shut water tight upon this iron band. The crown was hung to the iron band with hinges, so as to turn over sideways when open. To make it perfectly secure when shut it might be screwed down upon the band by the operator, or by a person without.

There were in the brass crown three round doors, one directly in front, and one on each side, large enough to put the hand through: when open they admitted fresh air; their shutters were ground perfectly tight into their places with emery, hung with hinges, and secured in their places when shut; there were likewise several small glass windows in the crown, for looking through and admitting light in the day time, with covers to secure them. There were two air-pipes in the crown. A ventilator within drew fresh air through one of the air pipes, and discharged it into the lower part of the vessel; the fresh air introduced by the ventilator, expelled the impure light air through the other air pipe. Both air pipes were so constructed that they shut themselves whenever the water rose near their tops, so that no water could enter through them, and opened themselves immediately after they rose above the water.

The vessel was chiefly ballasted with lead fixed at the bottom; when this was not sufficient, a quantity was placed within, more or less, according to the weight of the operator; its ballast made it so stiff, that there was no danger of its oversetting. The vessel, with all its appendages and the operator, was not of sufficient weight to settle it very low in the water. About two hundred pounds of the lead at the bottom for ballast could be let down forty or fifty feet below the vessel; this enabled the operator to rise instantly to the top of the water in case of accident.

When the operator would descend, he places his foot on the top of a brass valve, pressing it, by which he opened a large aperture at the bottom of the vessel, through this the water entered at his pleasure; when he had admitted a sufficient quantity, he descended very gradually; if he admitted too much, he ejected as much as was necessary to obtain an equilibrium by the two brass forcing pumps which were placed at each hand. Whenever the vessel leaked, or he would ascend to the surface, he also made use of these forcing pumps. When the skilful operator had obtained an equilibrium, he could row upward or downward, or continue at any particular depth, with an oar placed near the top of the vessel, formed upon the principle of the screw, the axis of the oar entering the vessel; by turning the oar one way, he raised the vessel, by turning it the other way he depressed it.

A glass tube, eighteen inches long and one inch in diameter, standing upright, its upper end closed, and its lower end, which was open, screwed into a brass pipe, through which the external water had a passage into the glass tube, served as a water-guage or barometer. There was a piece of cork, with phosphorus on it, put into the water-guage. When the vessel descended the water rose in the water-gauge, condensing the air within, and bearing the cork with its phosphorus on its surface. By the light of the phosphorus, the ascent of the water in the gauge was rendered visible, and the depth of the vessel under water ascertained by a graduated line.

An oar formed upon the principle of the screw was fixed in the fore part of the vessel; its axis entered the vessel, and being turned one way, rowed the vessel forward, but being turned the other way, rowed it backwards; it was made to be turned with the hand or foot.

A rudder hung on the hinder part of the vessel, commanded it with the greatest ease. The rudder was made very elastic, and might be used for rowing forward. Its tiller was within the vessel on the operator's

right hand, fixed at a right angle on an iron rod, which passed through the side of the vessel; the rod had a crank on its outside, which commanded the rudder by means of a rod extending from the end of the crank to a kind of tiller fixed on the left hand of the rudder. Raising or depressing the first-mentioned tiller, turned the rudder as the case required.

A compass marked with phosphorus, directed the course both above and under the water; and a line and lead sounded the depth when necessary.

The internal shape of the vessel in every possible section of it, verged towards an ellipsis as near as the design would allow; but every horizontal section of it, although elliptical, was as near to a circle as could be admitted. The body of the vessel was made exceedingly strong; and to strengthen it as much as possible, a firm piece of wood was framed parallel to the conjugate diameter, to prevent the sides from yielding to the great pressure of the incumbent water, in deep immersions. This piece of wood was also a seat for the operator.

Every opening was well secured. The pumps had two sets of valves. The aperture at the bottom for admitting water was covered with a plate perforated full of holes, to receive the water, and prevent any thing from choaking the passage, or stopping the valve from shutting. The brass valve might likewise be forced into its place by a screw if necessary. The air-pipes had a kind of hollow sphere fixed round the top of each to secure the air-pipe valves from injury: these hollow spheres were perforated full of holes for the passage of the air through the pipes: within the air-pipes were shutters to secure them, should any accident happen to the pipes or the valves on their tops.

Wherever the external apparatus passed through the body of the vessel, the joints were round, and formed by brass pipes, which were driven into the wood of the vessel, the holes through the pipes were very exactly made, and the iron rods that passed through them were turned in a lathe to fit them; the joints were also kept full of oil to prevent rust and leaking. Particular attention was given, to bring every part necessary for performing the operations, both within and without the vessel, before the operator, and as conveniently as could be devised; so that every thing might be found in the dark, except the water-gauge and the compass, which were visible by the light of the phosphorus, and nothing required the operator to turn to the right hand or to the left to perform any thing necessary.

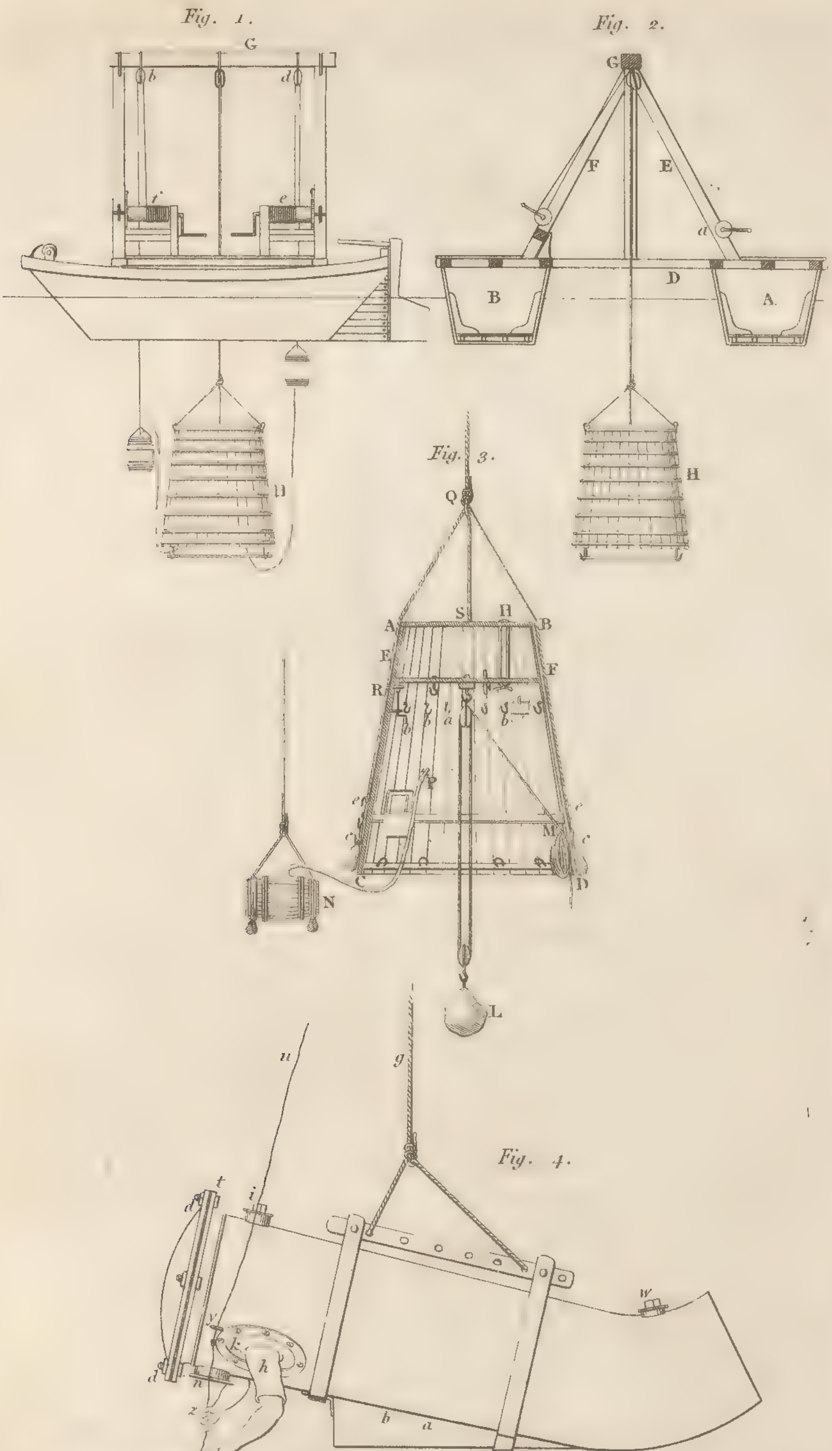
The intended object of this vessel was to destroy shipping, by the explosion of a magazine of gunpowder. In the fore part of the brim of the crown of the sub-marine vessel was a socket, and an iron tube passing through the socket; the tube stood upright, and could slide up and down in the socket six inches; at the top of the tube was a wood screw, fixed by means of a rod, which passed through the tube and screwed the wood screw fast upon the top of the tube; by pushing the wood screw up against the bottom of a ship, and turning it at the same time, it would enter the planks; driving would also answer the same purpose; when the wood screw was firmly fixed, it could be cast off by unscrewing the rod which fixed it upon the top of the tube.

Behind the sub-marine vessel was a place above the rudder for carrying a large powder magazine; this was made of two pieces of oak timber, large enough when hollowed out to contain 150 pounds of powder, with the apparatus used in firing it, and was secured in its place by a screw turned by the operator. A strong piece of rope extended from the magazine to the wood screw above-mentioned, and was fastened to both. When the wood screw was fixed, and to be cast off from its tube, the magazine was to be cast off likewise by unscrewing it, leaving it hanging to the wood screw; it was lighter than the water, that it might rise up against the object, and apply itself where fastened.

Within the magazine was an apparatus constructed to run any proposed length of time under twelve hours; when it had run out its time it unpinioned a strong lock resembling a gun-lock, which gave fire to the powder. This apparatus was so pinioned that it could not possibly move, till by casting off the magazine from the vessel it was set in motion.

The skilful operator could swim so low on the surface of the water, as to approach very near a ship in the night without fear of discovery, and might, if he chose, approach the stem or stern above water with very little danger. He could sink very quickly, keep at any depth he pleased, and row a great distance in any direction he desired, without coming to the surface; and when he rose to the surface, he could soon obtain a fresh supply of air, when, if

DIVING BELL.



J. Farey Junr. delin. Lowry sculp.

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necessary, he might descend again and pursue his course.

The projector found some time and attention to be requisite for the gradual instruction of this operator, and after various attempts he found one on whom he thought he could depend. He sent this man from New York to a 50 gun ship, lying not far from Governor's island. He went under the ship, and attempted to fix the wood screw in her bottom, but struck, as he supposed, a bar of iron, which passes from the rudder-hinge, and is spiked under the ship's quarter. Had he removed a few inches, which he might have done without rowing, the projector has no doubt but he might have found wood, where he might have fixed the screw; or, if the ship were sheathed with copper, he might easily have pierced it; but not being well skilled in the management of the vessel, in attempting to row to another place he lost the ship: after seeking her in vain some time, he rowed to some distance, and rose to the surface of the water, but found day-light had advanced so far that he durst not renew the attempt. He says he could easily have fastened the magazine under the stern of the ship above the water, as he rowed up to the stern and touched it before he descended. Had he fixed it there, the explosion of 150 pounds of powder (the quantity contained in the magazine) must have been fatal to the ship. In his return from the ship to New York, he passed near Governor's island, and thought he was discovered by the enemy on the island; being in haste to avoid the danger he feared, he cast off the magazine, as he imagined it retarded him in the swell, which was very considerable. After the magazine had been cast off an hour, the time the internal apparatus was set to run, it blew up with great violence.

Mr. Bushnell made some other trials, which may be seen on consulting the original, or Nicholson's Journal, quarto, iv. 229.

DIVINITY, properly signifies the nature, quality, and essence of the true God.

DIVISIBILITY, that property by which the particles of matter in all bodies are capable of a separation, or disunion from each other.

As it is evident that body is extended, so it is no less evident that it is divisible; for since no two particles of matter can exist in the same place, it follows, that they are really distinct from each other, which is all that is meant by being divisible. In this sense the least conceivable particle must still be divisible, since it will consist of parts which will be really distinct. To illustrate this by a familiar instance, let the least imaginable piece of matter be conceived lying on a smooth plain surface, it is evident the surface will not touch it every where: those parts, therefore, which it does not touch, may be supposed separable from the others, and so on, as far as we please; and this is all that is meant when we say matter is infinitely divisible.

The infinite divisibility of mathematical quantity is demonstrated thus geometrically. Suppose the line A D (Plate Miscel. fig. 7) perpendicular to B F, and another, as G H, at a small distance from it, also perpendicular to the same line: with the centres C, C, C, &c. describes circles cutting the line G H in the points *e*, *e*, *e*, &c. Now the greater the radius A C is, the less is the part *e* H. But the radius may be augmented in infinitum, so long therefore, the part *e* H may be divided into still less portions, consequently it may be divided in infinitum.

All that is supposed in strict geometry, (says Mr. Maclaurin) concerning the divisibility of magnitude, amounts to no more than that a given magnitude may be conceived to be divided into a number of parts, equal to any given or proposed number. It is true, that the number of parts into which a given magnitude may be conceived to be divided, is not to be fixed or limited, because no given number is so great but a greater may be conceived and assigned: but there is not, therefore, any necessity of supposing the number of parts actually infinite; and if some have drawn very absurd consequences from such a supposition, yet geometry ought not to be loaded with them.

Thus far we have shown that extension may be divided into an unlimited number of parts; but with respect to the limits of the divisibility of matter itself, we are perfectly in the dark. We can indeed divide certain bodies into surprizingly fine and numerous particles, and the works of nature offer many fluids and solids of wonderful tenuity; but both our efforts, and those naturally small objects, advance a very short way towards infinity. Ignorant of the intimate nature of matter, we cannot assert whether it may be capable of infinite division, or whether it ultimately consists of particles of a certain size, and of perfect

hardness. We shall now add some instances of the wonderful tenuity of certain bodies, which have been produced either by art, or discovered by means of microscopical observations amongst the stupendous works of nature.

The spinning of wool, silk, cotton, and such-like substances, affords no bad specimens of this sort; since the thread which has been produced by this means, has often been so very fine as almost to exceed the bounds of credibility, had it not been sufficiently well authenticated. Mr. Boyle mentions that two grains and a half of silk was spun into a thread 300 yards long. A few years ago, a lady of Lincolnshire spun a single pound of woollen yarn into a thread of 168,000 yards long, which is equal to 95 English miles. Also a single pound weight of fine cotton-yarn was lately spun, in the neighbourhood of Manchester, into a thread 134,400 yards long.

The ductility of gold likewise furnishes a striking example of the great tenuity of matter amongst the productions of human ingenuity. A single grain weight of gold has been often extended into a surface equal to 50 square inches. If every square inch of it is divided into square particles of the hundredth part of an inch, which will be plainly visible to the naked eye, the number of those particles in one inch square, will be 10,000; and multiplying this number by the 50 inches, the product is 500,000; that is, the grain of gold may be actually divided into at least half a million of particles, each of which is perfectly apparent to the naked eye. Yet, if those particles are viewed in a good microscope, they will appear like a large surface, the ten-thousandth part of which might by this means be easily discerned. An ingenious artist in London has been able to draw parallel lines upon a glass plate, as also upon silver, so near one another, that 10,000 of them occupy the space of one inch. Those lines can be seen only by the assistance of a very good microscope. Another workman has drawn a silver wire, the diameter of which does not exceed the 750th part of an inch. But those prodigies of human ingenuity will appear extremely gross and rude, if they are compared with the immense subtilty of matter which may every where be observed amongst the works of nature. The animal, the vegetable, and even the mineral kingdom, furnish numerous examples of this sort. What must be the tenuity of the odoriferous parts of musk, when we find that a piece of it will scent a whole room in a short time, and yet it will hardly lose any sensible part of its weight! But supposing it to have lost one-hundredth part of a grain weight, when this small quantity is divided and dispersed through the whole room, it must so expand itself as not to leave an inch square of space where the sense of smell may not be affected by some of its particles. How small must then be the weight and size of one of those particles! The human eye, unassisted by glasses, can frequently perceive insects so small as to be barely discernible. The least reflection must show, that the limbs, the vessels, and other parts of such animals, must infinitely exceed in fineness every endeavour of human art. But the microscope has discovered wonders that are vastly superior, and such indeed as were utterly unknown to our forefathers, before the invention of that noble instrument.

Insects have been discovered so small as not to exceed the 10,000th part of an inch: so that 1,000,000,000,000, of them might be contained within the space of one cubic inch; yet each animalcule must consist of parts connected with each other; with vessels, with fluids, and with organs necessary for its motions, for its increase, for its propagation, &c. How inconceivably small must those organs be! and yet they are unquestionably composed of other parts still smaller, and still farther removed from the perception of our senses.

DIVISION, in general, is the separating a thing into two or more parts. Although the mechanical division of bodies separates them into smaller parts, it cannot extend to the primary particles of any body, and is, consequently, incapable of breaking what is called the aggregation. Division is also reckoned among the terms in chemistry, but not very properly, as it is merely used preparatory to other operations, particularly solution: for this it is useful, as it increases the quantity of surface, and the points of contact of any body.

Division. See Algebra and Arithmetic.

Division, among logicians, is the explication of a complex idea, by enumerating the simple ideas whereof it is composed; in which sense it is nearly allied to definition, only that this last regards names and things, whereas division is employed wholly about ideas.

When the parts of an idea are divided,

in order to a clearer explication of the whole, this is called a subdivision: thus, a year is divided into twelve months, a month is subdivided into weeks, weeks into days, days into hours, and so on.

The rules for a good division are these, that the members entirely exhaust the whole; that they be opposite; that subdivisions be not too numerous; that the whole be first divided into its larger parts, and these into the more remote and minute parts.

Division, in natural philosophy, is the taking a thing to pieces, that we may have a more complete conception of the whole: this is frequently necessary in examining very complex beings, the several parts of which cannot be surveyed at one view. Thus, to learn the nature of a watch, the workman takes it to pieces, and shews us the spring, wheels, axles, pinions, balances, dial-plate, pointer, case, &c. and after describing the uses and figures of each of them apart, explains how they contribute to form the whole machine.

Division, in music, the dividing the interval of an octave into a number of less intervals. The fourth and fifth divide the octave perfectly, though differently: when the fifth is below, and serves as a bass to the fourth, the division is called harmonical; but when the fourth is below, it is called arithmetical. To run a division, is to play, or sing, after the manner abovementioned; that is, to divide the intervals of an octave, fifth, fourth, &c. into as many parts, and as agreeably as possible, which depends entirely upon taste and fancy.

Division *of proportion*. If four quantities be proportional, $a : b :: c : d$; then the assumption of the difference between the antecedent $a-b$, or $b-a$, to either the antecedent a, or consequent b, of the first ratio a to b; and the difference between the antecedents $c-d$ or $d-c$ to either the antecedent b, or consequent d of the second ratio c to d; is called division of proportion.

Division, in the sea-language, the third part of a fleet of men of war, and sometimes the ninth part: which last happens when the fleet is divided into three squadrons; for then each squadron is distributed into three divisions. See Tactics, Naval.

Divisions *of a battalion*, are the several parcels into which a battalion is divided in marching. The lieutenants and ensigns march before the divisions.

DIVORCE, a separation of two *de facto* married together; of which there are two kinds; one *a vinculo matrimonii*, from the very bond of marriage: the other *a mensa et thora* from bed and board. Causes for separation *a vinculo*, are consanguinity or affinity within the degrees prohibited, also *impuberty* or *frigidity;* where the marriage was merely void *ab initio*, and the sentence of divorce only declaratory of its being so. This divorce enables the parties to marry again: but in the other case a power for so doing must be obtained by act of parliament. The woman divorced *a vinculo matrimonii*, receives all again she brought with her. Divorce *a mensa et thora*, is where the use of matrimony, as the use of cohabitation of the married persons, on their mutual conversation, is prohibited for a time, or without limitation of time. And this is in cases of adultery, cruelty, or the like; in which case the marriage having been originally good, is not dissolved or affected as to the *vinculum* or bond. The woman under separation by this divorce, may sue by her next friend; and she may sue her husband in her own name for alimony. But the children which she hath after the divorce, shall be deemed bastards; for a due obedience to the sentence will be intended, unless the contrary be shewn.

DIURETICS. See Pharmacy.

DIURIS, in botany, a genus of the Gynandria Diandria class and order. Nectary dependent; petals nine; the five outer ones very large; of two shapes; column of the fructification reversed, with a lid at top. One species D. australasia described by Dr. Smith in Linnean Transactions.

DIURNAL, in astronomy, something relating to the day, in opposition to nocturnal, which regards the night.

Diurnal *arch*, the arch or number of degrees that the sun, moon, or stars describe between their rising and setting.

Diurnal *motion of a planet*, is so many degrees and minutes as any planet moves in twenty-four hours. Hence the motion of the earth about its axis, is called its diurnal motion.

DOBCHICK, a species of Colymbus.

DOCK, in maritime affairs, is a pit, great pond, or creek, by the side of an harbour, made convenient either for the building or repairing of ships. It is of two sorts: 1. Dry-dock, where the water is kept out by great flood-gates till the ship is built or repaired, when the gates are opened and the water let in to float and launch her.

2. Wet-dock, a place where the ship may be hauled into out of the tide's way, and so dock herself, or sink herself a place to lie in.

Docks, &c. Liverpool, Hull, and Bristol, but especially the two first of these places, had proved the advantages of wet-docks long before London possessed any such accommodations. The inconveniences arising from the crowded state of the river at all times, but particularly when ships arrived in large fleets, and from the want of sufficient wharf-room for discharging their cargoes, were long felt and complained of by all the principal merchants in London, who were subject to considerable losses from the delays in getting their goods landed, and the opportunities of plunder to which they were exposed. At length, about the year 1793, a plan was circulated for forming capacious wet docks, with wharfs and warehouses, in a convenient situation adjoining the Thames at Wapping; the project gave rise to much discussion, and to the formation of other plans accommodated to particular interests; but through the indefatigable perseverance of Mr. William Vaughan, assisted by other highly respectable mercantile characters, the original plan was matured, and a bill brought into parliament for carrying it into execution. Contending interests rendered the first application unsuccessful; and a few years after the corporation of London proposed to make a navigable canal or passage across the Isle of Dogs; while another plan was brought forward for making wet-docks for the West India shipping only; and afterwards one for making docks for East India shipping only, all in the vicinity of each other. These several undertakings, all arising out of the original project of the London docks, have been since carried into execution, to the great convenience of the commerce of the port of London, and the permanent benefit of the subscribers, by whom the large sums necessary for accomplishing them were advanced.

LONDON DOCK.

This company was established by an act of 39 and 40 Geo. III. passed the 20th of June, 1800, by which they were impowered to raise a capital stock of 1,200,000*l.*; and, if necessary, to borrow at interest the further sum of 300,000*l.*: but a larger capital being necessary for completing the undertaking, they applied to parliament for leave to augment their capital stock by any further sum not exceeding 500,000*l.*; and have since obtained another act for raising a further sum of 500,000*l.*; so that the total capital stock which the company are authorised to raise, if necessary, is 2,200,000*l.*

The company is under the management of twenty-four directors, who are elected annually. Two general courts of proprietors are held every year, at which all persons are entitled to vote who possess 500*l.* stock or upwards.

The dividends on their stock are restricted to 10 per cent. per annum, and are paid on the 1st of January, and the 1st of July. The present dividend is 5½ per cent, and the company pay the property tax thereon. The dividends are paid, and transfers made on any day except holidays.

The company was required to complete the docks within seven years, and on the 24th of January, 1805, they gave notice, by advertisement, that the bason at Bell-dock, and the dock communicating therewith, and also part of the warehouses, vaults, and quays, were ready for the reception of ships and landing their cargoes, in consequence of which the dock was opened for public use in the following week.

WEST INDIA DOCK.

This company was established by an act of 39 Geo. III. passed the 12th of July, 1799, and was impowered to raise a joint stock of 500,000*l*, with liberty to increase the same to 600,000*l.* by consent of the majority of proprietors at a general meeting. This increased capital was, however, found inadequate to complete the undertaking; and in 1802, the company were authorised to add 200,000*l.* to it, making the capital 800,000*l*, which has since been increased to 1,200,000*l.* Of this sum, 1,127,500*l.* has been called for; and a further subscription of 2½ per cent. was added in January, 1808. They were to pay 5 per cent. interest for the money advanced, until the docks were completed, and afterwards to make dividends not exceeding 10 per cent. per annum.

The company is under the management of twenty-one directors, eight of whom must be members of the Corporation of London. They are elected annually, five going out every year for three years, and six the fourth year.

Two general meetings of proprietors are to be held every year, in January and July, at which all persons are entitled to vote who hold 500*l.* stock or upwards.

Votes may be given by power of attorney.

The present dividend is 10 per cent. per annum, and becomes due the 1st of January and the 1st of July. The dividends are payable every day, and the company pay the property tax thereon.

The dock was opened the 27th of August, 1802.

EAST INDIA DOCK.

This company was established by an act of 43 Geo. III. passed the 27th of July, 1803, and was authorised to raise a capital of 200,000*l.* divided into shares of 100*l.* each, with liberty to increase their capital to 300,000*l.* if found necessary. In 1806 they were impowered to add 100,000*l.* to their capital, making with the former sum 400,000*l.* nearly the whole of which has been raised. They were to pay 5 per cent. interest on the money advanced; and after the docks should be completed to make dividends not exceeding 10 per cent. per annum.

The company is under the management of thirteen directors, who must be holders of at least twenty shares of the company's stock, and four of them must be directors of the East India company. They are elected annually in July, and three go out every year.

Two general meetings are held yearly, in January and July, at which proprietors of five shares and upwards are entitled to vote. They must also be directors of the East India company, or have been so within two years, or be an agent, husband, consignee, or owner, to the value of 500*l.* or upwards, of East India shipping.

The present dividend is at the rate of 5 per cent. per annum, and is payable at Lady-day and Michaelmas, every day except Fridays, between the hours of 11 and 2 o'clock.

The dock was opened in August, 1806.

DOCK *yards*, in ship building, are magazines of all sorts of naval stores. The principal ones in England are those of Chatham, Portsmouth, Plymouth, Woolwich, Deptford, and Sheerness. In time of peace ships of war are laid up in these docks; those of the first rates mostly at Chatham, where, and at other yards, they receive from time to time such repairs as are necessary. These yards are generally supplied from the northern crowns with hemp, pitch, tar, rosin, &c.; but as for masts, particularly those of the larger size, they are brought from New England.

DOCKET or DOGGET, a brief in writing, on a small piece of paper or parchment, containing the effect of a larger writing, and annexed to other papers for particular purposes. In law a docket is necessary in all judgments, and no debts will be entitled to a preference in debts, due from a party deceased, as judgment debts, unless such judgments be regularly docketed.

DOCTOR, a person who has passed all the degrees of a faculty, and is impowered to teach or practise the same: thus we say, doctor in divinity, doctor in physic, doctor of laws.

The title of doctor seems to have been created in the XIIth century, instead of master, and established with the other scholastic degrees of batchelors and licentiates, by Peter Lombard and Gilbert Porreus, then the chief divines of the University of Paris. Gratian did the same thing at the same time, in the University of Bologna. Though the two names of doctor and master were used a long time together, yet many think that their functions were different, the masters teaching the human sciences, and the doctors those sciences depending on revelation and faith. Spelman takes the title of doctor not to have commenced till after the publication of "Lombard's Sentences," about the year 1140, and affirms that such as explained that work to their scholars were the first that had the appellation of doctors.

To pass doctor in divinity at Oxford, it is necessary the candidate have been four years batchelor of divinity. For doctor of laws, he must have been seven years in the university to commence batchelor of law, five years after which he may be admitted doctor of laws. Otherwise in three years after taking the degree of master of arts, he may take the degree of batchelor in laws, and in four years more that of doctor: which same method and time are likewise required to pass the degree of doctor in physic. At Cambridge, to take the degree of doctor in divinity, it is required the candidate have been seven years batchelor of divinity: though in several colleges the batchelor's degree is dispensed with, and they may go out *per saltum*. To commence doctor in laws, the candidate must have been five years batchelor of laws, or seven years master of arts. To pass doctor in physic he must have been batchelor in physic five years, or seven years master of arts. It is

markable, that by a statute of 37 Hen. VIII. a doctor of civil law may exercise ecclesiastical jurisdiction, though a layman.

Doctor in music, a musician upon whom some university has conferred the degree of doctor in the faculty of music. By the qualifications formerly required of a candidate either for a doctor's or batchelor's degree in music, it should seem that the science was regarded merely as speculative. The present statutes, however, are formed on a broader principle, and looking to talent and active science for the necessary qualifications, require of the candidate an exercise in eight vocal parts, with instrumental accompaniments, which he is to submit to the inspection of the musical professor, and to have performed in the music school, or some other public place in the university.

DODARTIA, in botany, so called in honour of M. Dodart, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-toothed; corolla lower lip twice as long as the upper; capsule two-celled, globular. There are two species, *viz.* D. orientalis, oriental dodartia, and D. indica, natives of India.

DODECAHEDRON, in geometry, one of the Platonic bodies, or regular solids, contained under twelve equal and regular pentagons. See Body.

DODECANDRIA, the name of the eleventh class in Linnæus's Sexual System; consisting of plants with hermaphrodite flowers, that, according to the title, have twelve stamina or male organs. This class, however, is not limited with respect to the number of stamina. Many genera have sixteen, eighteen, and even nineteen stamina; the essential character seems to be that, in the class in question, as in Polyandria, the 13th, the stamina are inserted into the receptacle: whereas in the intermediate class, Icosandria, which is as little determined in point of number as the other two, they are attached to the inside of the calyx. The orders in this class, which are six, are founded upon the number of the styles, or female organs. Asarabacca, mangostan, storax, purple loose-strife, wild Syrian rue, and purslane, have one style; agrimony and heliocarpus have two; burning thorny plant and bastard rocket three; glinus five; illicium eight; and houseleek twelve.

DODECAS, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Calycanthemæ. Myrti, Jussieu. Essential character: corolla five-petalled; calyx half four-cleft, bearing the corolla, superior; capsule one-celled, connate with the calyx. There is but one species, *viz.* D. surinamensis, a native of Surinam.

DODECATHEON, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla rotate, reflex; stamina placed on the tube; capsule one-celled, oblong. There is only one species, *viz.* D. meadia. Virginian cowslip, or meadia, has a perennial yellow root, from which come out in the spring, several long smooth leaves, six inches long, and nearly two broad; at first they stand erect, but afterwards they lie on the ground, especially if the plant be much exposed to the sun; from among these leaves arise three or four flower stalks, eight or nine inches high, they are smooth, naked, and terminated by an umbel of flowers, of a peach coloured blossom; these appear in April or May; the seeds ripen about July, soon after which the leaves decay, and the roots remain inactive till the following spring. It is a native of Virginia, and many parts of North America.

DODO. See Didus.

DODONÆA, in botany, so named in honour of Rembert Dodonæus, a famous botanist of the sixteenth century, a genus of the Octandria Monogynia class and order. Natural order of Dumosæ. Terebintaceæ, Jussieu. Essential character: calyx four-leaved; corolla none; capsule three-celled, inflated; seeds in couples. There are two species, *viz.* D. viscosa, broad-leaved dodonæa, and D. angustifolia, narrow-leaved dodonæa. The former is a native of the countries between the tropics, the latter is found at the Cape of Good Hope.

DOG. See Canis.

Dog *days*, the same with those called canicular. See Canicular *days*.

DOLICHOS, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: two parallel oblong calluses at the base of the standard, compressing the wings underneath. There are thirty-eight species; most of these are annual, and natives either of the East or West Indies. They are chiefly herbaceous, with twining stalks: the flowers are frequently in spikes, and axillary; the legume is often smooth, sometimes villose, or prunient.

Mr. Millar affirms that he has cultivated more than sixty, besides many varieties.

DOLIOCARPUS, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx five-leaved; corolla three-petalled, plaited; stigma sub-bifid; berry globular, crowned with a style, one-celled, two-seeded. There are three species.

DOLPHIN. See DELPHINUS.

DOMBEYA, in botany, so called in memory of Jos. Dombey, a genus of the Dioecia Monadelphia class and order. Natural order of Coniferæ. Essential character: male, calyx of the ament; scales terminated by a leaflet; corolla none; anthers ten or twelve, without filaments. Female, calyx ament, with many germs; corolla none; stigma bivalve, unequal; seeds many in a roundish strobile. There is but one species, *viz.* D. chilensis, a tree very little known, of a resinous nature, in some respects allied to protea; and also to the pines in some particulars of its fructification; the trunk is straight, and of considerable height; the wood is white, solid, and clothed with a kind of double bark. The flowers are male and female, borne on different individuals, and hang in sessile solitary catkins from the top of the branches. A native of Chili.

DOME, in architecture, a spherical roof, or a roof of a spherical form, raised over the middle of a building, as a church, hall, pavilion, vestible, stair-case, &c. by way of crowning. See ARCHITECTURE.

DOMESDAY, or DOOMS-DAY-BOOK, a very ancient record made in the time of William the Conqueror, which now remains in the Exchequer, and consists of two volumes, a greater and a less; the greater contains a survey of all the lands in most of the counties in England, and the less comprehends some counties that were not then surveyed. The book of domesday was begun by five justices, assigned for that purpose in each county, in the year 1081, and finished in 1086. It was of that authority, that the Conqueror himself submitted, in some cases wherein he was concerned, to be determined by it. Camden calls this book the tax-book of king William; and it was farther called magna rolla. There is likewise a third book of domesday, made by command of the Conqueror; and also a fourth, being an abridgment of the other books.

DOMINICAL *letter*, in chronology, is that letter of the alphabet which points out in the calendar the Sundays throughout the year, thence also called Sunday letter. See CHRONOLOGY.

DONATIA, in botany, a genus of the Triandria Trigynia class and order. Essential character: calyx three-leaved; petals nine, twice as long as the calyx, linear oblong; anthers sub-globular, twin. There is but one species, *viz.* D. fascicularis.

DONAX, in natural history, a genus of Vermes Testacea. Generic character: animal a tethys; shell bivalve, generally with a crenulate margin, the frontal margin very obtuse; hinge with two teeth, and a single marginal one placed a little behind, rarely double, triple, or none. There are nineteen species. D. scortum is a triangular heart-shaped shell, with a flat frontal margin. It inhabits the Indian ocean; cinereous, mixed here and there with violet, within snowy, except near the hinge, which is violet; marginal teeth, double in each valve, with an intermediate cavity. D. scripta inhabits the coast of Malabar, it is elegantly painted with angular reddish, blue, or brown lines; the hinge something resembles that of a Venus.

DOOR, in architecture, an aperture in a wall, to give entrance and exit into and out of a building, or any apartment thereof. See ARCHITECTURE.

DORÆNA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla five-cleft; stigma emarginate; capsule one-celled. One species, *viz.* D. japonica, a native of Japan.

DORIC *order*, in architecture, the second of the five orders, being that between the Tuscan and Ionic. See ARCHITECTURE.

DORIC *dialect*, in grammar, one of the five dialects, or manners of speaking which were principally in use among the Greeks.

DORIS, in natural history, a genus of the Vermes Mollusca. Generic character: body creeping, oblong and flat beneath: mouth placed below, on the fore part; vent behind on the back, and surrounded by a fringe; feelers two to four, seated on the upper part of the body in front, and retractile within their proper receptacles. There are twenty-four species, in two sections: A. tentacula, or feelers, four: B. two tentacula only: D. argo, inhabits different parts of our seas, and called in the neighbourhood of Brighton the sea-lemon. This has an oval body, convex, marked with numerous punctures, is of a lemon-colour, hence its trivial name; the vent is beset with elegant ramifications. D. verrucosa,

or warty doris, found in the sea near Aberdeen, is of an ovated form, convex, and tuberculated.

DORYCHIUM, in botany, a genus of the Diadelphia Decandria class and order: calyx five-toothed, two-lipped; filaments subulate; stigma capitate; legume turgid, one or two seeded. There are three species, found in France and Spain.

DORMANT, in heraldry, is used for the posture of a lion, or any other beast, lying along in a sleeping attitude, with the head on the fore paws; by which it is distinguished from the couchant, where, though the beast be lying, yet he holds up his head.

DORONICUM, in botany, leopard's bane, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbeferæ, Jussieu. Essential character: calyx scales in two rows equal, longer than the disk; seeds of the ray naked, and destitute of down; down to those of the disk simple; receptacle naked. There are three species, they grow naturally in Germany, France, and Spain.

DORSTENIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: receptacle common, one-leafed, fleshy, in which solitary seeds nestle. There are eight species.

DOSSIL, lint made into a cylindric form. See SURGERY.

DOUBLE *letter*, in grammer, a letter which has the force and effect of two. The Greeks have three of these, *viz.* Z, Ξ, Ψ; the Latins have two X and Z; and most of the modern languages have the same.

DOUGLASSIA, in botany, so named in honour of James Douglas, M. D., a genus of the Polyadelphia Polyandria class and order. Essential character: calyx half six-cleft; corolla none; nectary six; filaments none; germ superior; stigma six-cleft; berry ovate, one-celled; seed one, with a brittle shell. There is but one species, *viz.* D. guianensis, guiana douglassia.

DOVE *tailing*, in carpentry, is the manner of fastening boards together by letting one piece into another, in the form of the tail of a dove. The dove-tail is the strongest of the assemblages or jointings, because the tenon, or piece of wood which is put into the other, goes widening to the extreme, so that it cannot be drawn out again by reason of the extreme or tip is bigger than the hole.

DOWER, the portion which a widow hath of the lands of her husband, after his decease, for the sustenance of herself, and the education of her children.

DOWER *by the common law* is a third part of such lands or tenements whereof the husband was sole seised in fee-simple, or fee-tail, during the marriage, which the wife is to enjoy during her life; for which there lies a writ of dower.

DOWER *by custom.* This kind of dower varies according to the custom and usage of the place, and is to be governed accordingly; and where such custom prevails, the wife cannot wave the provision thereby made for her, and claim her thirds at common law, because all customs are equally ancient with the common law itself.

DOWER *ad ostium ecclesiæ*, is where a man of full age, seized of lands in fee, after marriage, endows his wife at the church door of a moiety, a third, or other part of his lands, declaring them in certainty; in which case, after her husband's death, she may enter into such lands without any other assignment, because the solemn assignment at the church door is equivalent to the assignment *in pais* by metes and bounds; but this assignment cannot be made before marriage, because before she is not entitled to dower.

DOWER *ex assensu patris*, is where the father is seised of lands in fee; and his son and heir apparent after marriage endows his wife by his father's assent, *ad ostium ecclesiæ*, of a certain quantity of them; in which case after the death of the son, his wife may enter into such parcel without any other assignment, though the father be living; but this assent of the father's must be by deed, because his estate is to be charged *in futuro*, and this may likewise be of more than a third part.

The dowers *ad ostium ecclesiæ*, or *ex assensu patris*, if the wife enter and assent to them, are a good bar of her in common law; but she may, if she will, wave them, and claim her dower at common law, because being made after marriage, she is not bound by them.

DOWN, the shortest, smoothest, softest, and most delicate feathers of birds, particularly geese, ducks, and swans; growing on their neck and part of the stomach. Down is a commodity of most countries; but that in most repute for fineness, lightness, and warmth, comes from Denmark, Sweden, and other northern countries. There is a down called ostrich down, otherwise ostrich's

hair, and sometimes wool: it is of two sorts, that called the fine is used by hatters in the manufacture of common hats, while the coarse is used for making list for white cloth.

DOXOLOGY, an hymn used in praise of the Almighty, distinguished by the title of greater and lesser.

DRABA, in botany, English *whitlow grass*, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ, or Cruciformes. Cruciferæ, Jussieu. Essential character: silicle entire, oval oblong; valves flattish, parallel to the dissepiment; style none. There are nine species, of which one is D. aizoides, hairy-leaved Alpine whitlow grass. It has a perennial root; the stem is three inches high: petals entire, silicle, hairy, rough, ovate, sharp at both ends; ending in a long style. This is a pretty plant, well adapted to rock work, having a sweet smell. It is a native of the mountains of France, Switzerland, Savoy, Austria, and Silesia.

DRACHM, a Grecian coin of the value of seven pence three farthings. This was also the name of a kind of weight, consisting of three scruples, and each scruple of two oboli. As to the proportion that the drachm of the Greeks bore with the ounce of the Romans, Q. Remnius, in his poem of weights and measures, makes the drachm the eighth part of an ounce, not much different from the crown of the Arabians, which weighs something more than the drachm.

DRACHM is also a weight used at present by physicians, containing sixty grains, or the eighth part of an ounce.

DRACO, the *dragon*, in natural history, a genus of Amphibia of the order Reptiles. Generic character: body four-footed, and tailed, and supplied on each side with an expansile membrane, strengthened by radii or bony processes. Of these animals there is only one species, D. volans, or the flying dragon. This is about four inches in length, exclusively of the tail, which is generally six or seven. Its colour is a beautiful pale blue. It abounds in various parts of Africa and Asia, and resembles the genus of lizards (to which it has by some naturalists been attached) in ranging along the boughs, feeding on the insects which are, in those situations, amply supplied for its subsistence. It is perfectly gentle and inoffensive. It is distinguished from lizards by being accommodated with large expansile, cutaneous processes, supported by ribs which reach to the extremity of this membrane, and by which the animal contracts or extends it. This representation of the flying dragon is totally different from what must be expected by those who are unacquainted with natural history, and whose ideas of the dragon are formed on the monstrous creations of poetry and romance. Though little adapted to excite terror, however, the flying dragon is well calculated to gratify curiosity. See Amphibia, Plate I. fig. 1.

DRACO, a constellation of the northern hemisphere. See ASTRONOMY.

DRACOCEPHALUM, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Scrophulariæ, Jussieu. Essential character: corolla throat inflated, upper lip concave. There are fifteen species. These are mostly herbaceous. The stalks are square, the leaves opposite in pairs. The flowers are either in worls, forming altogether a spike at the end of the stalk, or axillary on one-flowered or many-flowered peduncles; they are supported by bractes, which are generally broad, and sometimes ciliate.

DRACÆNA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: corolla six-parted, erect; filaments somewhat thicker in the middle; berry three-celled, one-seeded. There are fourteen species, mostly natives of the East Indies and Cochin China.

DRACONTIUM, in botany, a genus of the Gynandria Polyandria class and order Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spathe boat-form; spadix covered; calyx none; petals five; berries many-seeded. There are five species, of which D. polyphillum has a large, knobbed, irregular root, covered with a rugged brown skin. The stalk rises about a foot in height, it is smooth, and of a purple colour, full of sharp protuberances of various shades, shining like the skin of a serpent; it is naked to the top, where it has a tuft of leaves, divided into many parts. The flower-stalk rises immediately from the root, and is seldom more than three inches high, having an oblong swelling hood at top, which opens lengthwise, showing the short, thick, pointed style within, upon which the flowers are closely ranged. This plant grows naturally in several islands of America.

DRAGON. See DRACO.

DRAGON'S *blood*. See PHARMACY.

DRAINING. See AGRICULTURE.

DRAMA, a poem in which the action is represented.

To the Greeks we owe the invention of both forms of dramatic composition, tragedy and comedy. These exhibitions were extremely simple. The action was continued from beginning to end, without pauses or intervals; there was no change of scene: and the attention of the spectators was continually occupied either by the actors or the chorus. It was necessary, therefore, in order to give probability to the fiction, that the rule of the three unities should be strictly observed. The poem was confined, and the same action, out of which arose the incidents requisite to support it to its conclusion, and all tending to one great point. No episodes were admissible but such as were so connected with the main story as not to be suppressed or transposed without altering or destroying the plot. The unity of place, on a stage which admitted of no change of scene, must, of course, be rigorously attended to, and the fable so constructed as to draw all the characters to the same spot. This, notwithstanding the inconveniences which arose from it, was an indispensable rule, as any violation of it would completely destroy the illusion. The time, strictly speaking, was that of the representation. It might comprehend twenty-four hours, but by no means could it extend beyond that time. The precept of Aristotle even goes to describe the length of the poem; it could not exceed thirteen or fourteen hundred verses.

A drama composed on these principles could afford but little variety of incident and character; it must depend for its success on the poetical talent of its author, and on the interest he could thereby excite in the breasts of his audience, for the characters he introduced.

The modern stage gives wider scope to the imagination, and renders the strict observance of the unities less necessary. The introduction of pauses by the division of acts justifies a change of scene, and also allows a longer extension of time, without any violation of probability. Thus, a greater range of subjects for dramatic representation is provided, while at the same time as the obstructions of art are removed, the mirror, if we may so express it, becomes more true to nature. The poet may so construct his drama as to lead the imagination of his audience along with him, and thus may pass in review the striking events of history; while, by the aid of scenic illusion, the transition from place to place, becomes as consistent with probability as the transition from one period of time to another.

Yet there are who insist on the application of the Grecian rules to the modern drama. The French, in particular, observe them strictly. Their best pieces are composed on the ancient model; the scene never changed, and the action continued and ended on the same spot where it is supposed to begin. The time, likewise, seldom exceeds that prescribed by the Greek critic, and is often confined to that of the representation. Hence the national taste is so decidedly formed, that the best production of the English school would only afford them matter of ridicule, for its obvious violation of the long-established laws of criticism.

The unity of action is certainly essential to that probability which supports the theatrical illusion. Yet even the observance of this rule is not incompatible with variation of scene and extension of time, though it requires a masterly genius to manage them judiciously. In the works of our immortal Shakspeare we often see this talent exemplified. We behold in his Macbeth the transition from the hero to the villain, and view the awful retribution, though long withheld, yet finally overwhelm the guilty. Yet who thinks of objecting to so grand a play, because the scene shifts from Inverness to the English court and back again, or because a period of seventeen years elapses from the murder of Duncan to the death of the usurper.

Hence the rules ought to be subservient to the great end of dramatic representation, the instruction of mankind by impressive and striking lessons, and we may conclude with our great critic, that "the unities of time and place are not essential to a just drama; and that though they may sometimes conduce to pleasure, they are always to be sacrificed to the nobler beauties of variety and instruction; that a play written with nice observation of critical rules is to be contemplated as an elaborate curiosity, as the product of superfluous and ostentatious art, by which is shown rather what is possible than what is necessary."

DRAPERY, in sculpture and painting, signifies the representation of the clothing of human figures, and also hangings, tapestry, curtains, and most other things that are not carnations or landscapes. See Painting and Sculpture.

DRASTIC, in physic, an epithet bestowed on such medicines as are of present efficacy, and potent in operation; and is commonly applied to emetics and cathartics.

DRAUGHT, in trade, called also cloff or clough, is a small allowance on weighable goods, made by the king to the importer, or by the seller to the buyer, that the weight may hold out when the goods are weighed again.

The king allows 1*lb.* draught for goods weighing no less than 1*cwt.*; 2*lb.* for goods weighing between 1 and 2*cwt.*; 3*lb.* for goods weighing between 2 and 3*cwt.*; 4*lb.* from 3 to 10*cwt.*; 7*lb.* from 10 to 18*cwt.*; 9*lb.* from 18 to 30, or upwards.

DRAWBACK, in commerce, an allowance made to merchants on the re-exportation of certain goods, which in some cases consists of the whole, in others of a part of the duties which had been paid upon the importation.

Drawbacks were probably originally granted for the encouragement of the carrying trade, which, as the freight of ships is frequently paid by foreigners in money, was supposed to be a more certain source of wealth than other branches of foreign trade. They are granted not only on foreign commodities which have paid a duty on importation, but also on the exportation of such home manufactures as are subject to excise duties.

Upon the exportation of some articles of foreign produce, of which the quantity imported greatly exceeds what is necessary for the home consumption; the whole of the duties which had been paid on importation are drawn back. Thus, while the American states were under the dominion of Great Britain, we had the monopoly of the tobacco of Maryland and Virginia, of which about 96,000 hogsheads were annually imported, while the home consumption did not exceed 14,000: to facilitate the great exportation which was necessary in order to get rid of the surplus, the whole duties were drawn back, provided the exportation took place within three years.

Drawbacks are paid by the collector of the customs at the port where the goods are exported, on producing a debenture authenticated by the proper officers, as the authority or voucher for the payment.

Drawbacks can never, it is probable, be injurious; for they can never turn to any particular employment a greater share of the capital of the country than would naturally go to that employment. They only prevent the natural tendency of capitals from being deranged by taxation. When the duties paid on the exportation of sugar or tobacco, are returned on their exportation, the trade in those articles is only replaced on the situation it would have been in, if the articles had not been taxed.

A still more equitable arrangement than that of drawbacks, is, to allow the merchant who imports any commodity which he may probably wish to export again, to deposit it in the King's warehouses, giving a bond for payment of the duties, should he dispose of it for home consumption. This is called bonding, and is allowed to a considerable extent.

DRAWBRIDGE, a bridge made after the manner of a floor, to draw-up, or let down, as occasion serves, before the gate of a town or castle. See Bridge.

DRAWING is the art of expressing with accuracy, the imaginary outline, or true boundary, of objects of every description on any plain superfices. This pleasing method of preserving the forms of persons and places, long after the originals have perished, or entirely changed, has been cultivated from the most remote antiquity, and received many improvements, which were frequently lost and recovered through the temporary patronage and neglect of the rich, under whose auspices only the art of drawing can ever flourish. To form a just conception of the earliest state of drawing, it will be necessary to recur to the distorted forms produced by man in an uncultivated state of nature, in which we may discover genius struggling with ignorance, and always without success; such were the productions of the first population of the world, and such are still the productions of European youth before the kind hand of experience has pointed out the paths of correctness and taste. The scriptures furnish numerous proofs that the art of drawing had before their date arrived to considerable perfection, and the remains of Egyptian sculpture still extant, shew that people to have been tolerable proficients in delineating the outlines of men and animals, but the ancient Greeks appear to have studied nature with infinitely greater success, and we are indebted to them for the best of statues, formed with exquisite skill, from the most noble and graceful models of male and female beauty, which cannot be too frequently examined,

and copied, by the student who wishes to excel. The Romans, inspired by emulation, imitated the Greeks, and although they never attained the excellence of their masters, have left multiplied specimens of correct knowledge in the human outline. Long after the fall of their empire, Italy produced a succession of men who brought the art of drawing almost to its greatest possible perfection, of those Michael Angelo and Rafaelle were particularly celebrated, and though the latter seems to be most admired for his taste and correctness, the former once convinced him he had drawn the figures too small in a painting of Galatea, on the ceiling of a chamber in Il PiccioloFarnese, by sketching a large and admirable head of a Faunus on a wall with charcoal, which was preserved with the utmost care in Keysler's time, who relates the circumstance. Roused by the successful exertions of the Italians, every nation in Europe made their works their study, and many persons at different periods might be mentioned belonging to each, who have excelled in particular branches of drawing, nor are the modern English at all inferior to their rivals in this essential foundation of all the ramifications of the fine arts, as without truth in the drawing or formation of the outlines, a statue becomes a disgusting copy of human deformity, and objects delineated in painting or water colours destitute of this requisite, the representations of creatures of the fancy unlike those of nature or of art: from these positions it must be obvious that the student should begin his operations with the greatest caution, acquiring a thorough knowledge of geometry, and the laws of perspective, which will enable him to comprehend the various circular forms adopted by nature, and the peculiar shapes they assume when placed in particular positions.

Drawing may be practised with lead, chalk, crayons, charcoal, water-colours, and Indian ink.

To proceed regularly and methodically, the learner must be provided with wove paper, in other words drawing paper, without wire marks, of different thicknesses and sizes, and middle tint paper brown or grey, equally calculated to shew the white and black chalks, or coloured, for which it is expressly intended. As paper, when wet, will present an uneven surface, it becomes necessary to stretch it during the operation of colouring by means of drawing boards, one description of which is merely a strong and true square of deal secured from warping, on which the paper may be fastened by wetting it with a sponge, tracing a border of paste or glue along the edges, and laying it smooth on the board, thus prevented from blistering, the drawing may be cut away from the border of paste when completed; but the most convenient board is composed of a square frame, with a moveable pannel, on which the paper is laid wet, then pressed into the frame, and secured by wedges on the back when it will dry perfectly even, and become fit for use.

Other instruments required, are, compasses, for ascertaining distances between lines, forming circles, taking measurements by scale, &c. &c.; a steel pen, for drawing very fine clear lines; a parallel ruler, formed of two pieces of hard black wood fastened together by brass bands, turning on pivots at the extremities so exactly, that when opened, lines drawn along the outward half, must be parallel with the half held firm on the paper; and a T ruler, or square, so contrived as to supersede the above on the drawing board, by applying the stock or shortest end to the edge of the board, where it is slid backwards or forwards, and the long part used for tracing the line.

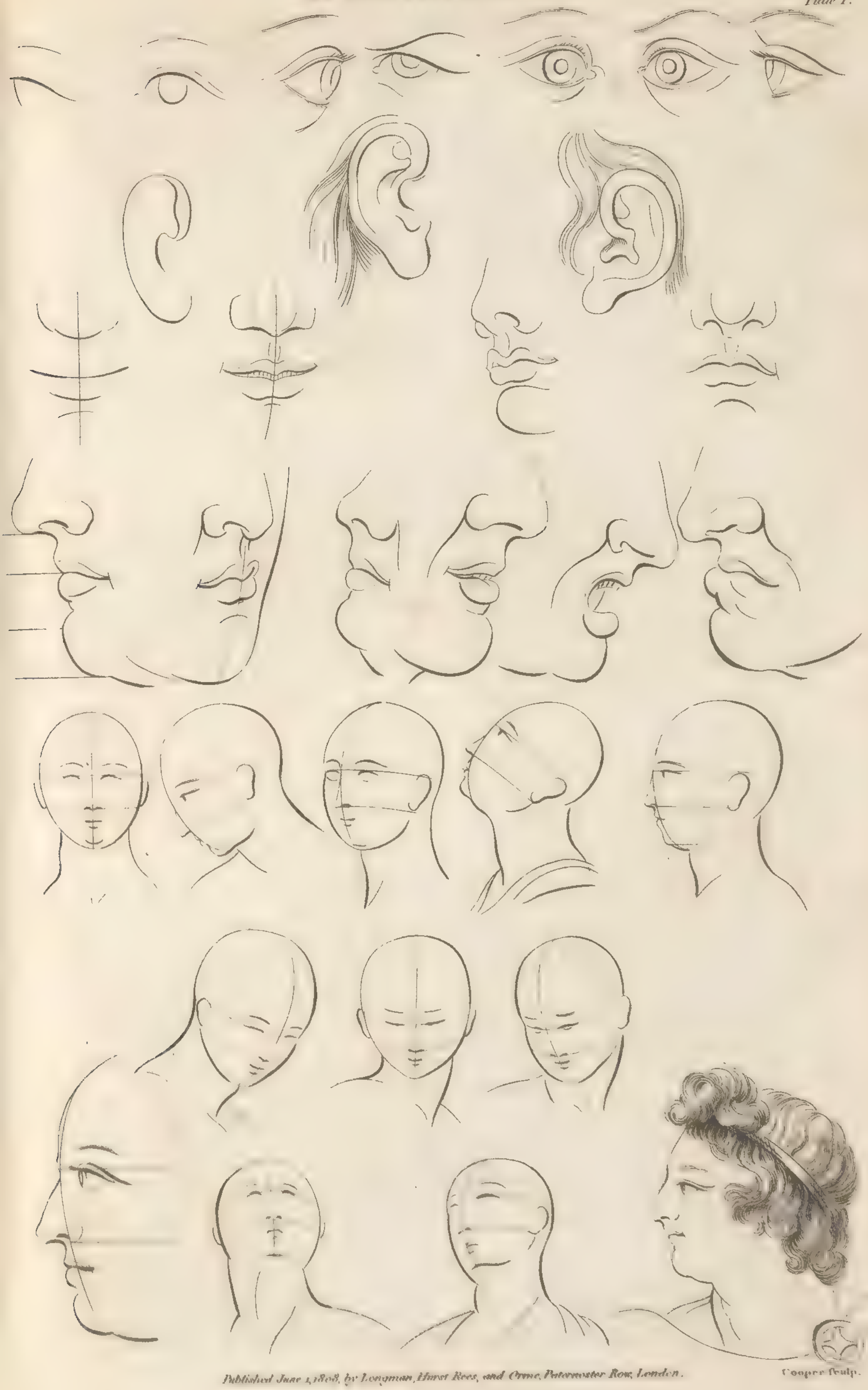
The materials for drawing are, black-lead cut into long pieces, and inclosed in red cedar, the greatest care should be taken in the choice of black-lead pencils, as the inferior are nothing more than fragments of this mineral united by glue, which cannot be brought to a point by a knife, or made to produce a line for a minute together; on the contrary the genuine black-lead cuts with ease, and yet has so much solidity that considerable pressure will not break a taper point.

Indian-rubber, which is used for cleansing off erroneous lines made by the black-lead pencil, this singular substance imported principally from South America in the shape of small bottles, and the East Indies in other forms, is composed of the gum of a tree, which in hardening becomes elastic, and possesses a strong adhesive property, extremely useful for removing dirt from drawings and prints.

Indian-ink is another valuable material, brought from China, where the secret of making it still remains, the real imported ink bears certain Chinese characters, breaks smooth and shining, is not gritty, and when used appears of a clear brownish black. The English imitation may be known by the harshness of its component parts.

DRAWING.

Plate I.



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Cooper sculp.

Hair-pencils. The Chinese who use the Indian-ink for writing, with a brush, make them very excellent for drawing, with white hair drawn through a reed; but those are difficult to procure, and camel's hair inserted in various sized quills are substituted, which are tried by slightly wetting them, if they form a point without separating, they are fit for use.

Chalks. It is common to sketch the outlines of figures with charcoal made from the willow, previous to the use of the chalk, as whatever errors may be committed with this material are easily effaced by the feathers from the wing of a duck or goose.

White chalk, for drawing, is harder than the common chalk, and pipe clay will make a good substitute.

Black chalk, is a hard fossil substance, cut into the shape of slate pencils, and used in steel or brass port-crayons, and with the white is constantly preferred in the model room of the Royal Academy, the professors of which, consider it the best material for drawing from plaster figures or the life, red chalk is but little used at present. The French chalk is softer than the Italian.

Stumps made of soft leather, or paper rolled into cylinders, and pointed, are necessary for blending the lights and shades.

Thus prepared, the student must confine himself to the copying of single subjects, and by no means attempt groupes of objects, as the eye, more rapid than thought, will wander over them, and confound his ideas, not yet taught the faculty of discrimination; to attain this faculty, it is absolutely necessary to advance progressively, commencing with the geometrical figures of arches, circles, ovals, cones, cylinders, and squares, which, except the latter, have an evident resemblance to many of the forms of nature, and accurately attain the shading which produces their rotundity, convexity, angles, and most remote parts from the eye. Grapes detached from, or adhering in clusters to the stalk, and many other fruits with their leaves, furnish excellent hints for the acquiring of graceful turns, and the art of placing justly, strong, direct, and reflected lights. Those require no rules or directions whatever, even in the colouring, as the tints may be composed from the originals. Trees should also be drawn singly, carefully observing the nature of the bark, the characteristics of the trunk, the particular ramifications of the branches, the form of the leaves, and their appearance in the aggregate, so that an observer shall, upon the first inspection of the drawing, pronounce whether it is an oak, an elm, an ash, or a poplar.

Animals may be the next object of the learner's attention, a knowledge of the forms of which will be best obtained by examining the most approved drawings and prints, copying them and comparing them with living subjects, carefully avoiding in future such errors as may be discovered; he may then proceed to the human figure, commencing his labours with drawing the eye, mouth, nose, feet, hands, &c. separately, till he is perfect, when the whole figure may be attempted. The copying of inanimate substances requires but few directions, as they lay fixed, and may be placed in any position; but it is far otherwise in drawing from animals or man, for which reason an accurate knowledge of the true shape of the bones, the disposition of the muscles, and the exact relative proportions of the different parts of the body must absolutely be acquired; nor is this all that is necessary, motion continually varying the appearance of the muscles, the student must learn from living subjects every swell or depression in them which is not the consequence of unnatural distortion; as there are certain limits to their motion, he should be capable of ascertaining those limits correctly from remembrance. It having pleased the divinity to grant the human race the most graceful variety of curved forms throughout the exterior of their frames, and each being subject to sudden and unexpected changes, we may safely assert the artist has a most difficult task in his attempts to delineate them; in order to do so successfully, it would be well for him to imitate the parts already mentioned from good drawings, with black lead or black chalk, on either of the papers before recommended, endeavouring to give a close resemblance of the outlines with charcoal, and then shading with the greatest care, after the original, in parallel lines of greater or less strength, according with the curve to be expressed, those to be intersected by others forming lozenge intervals; this mechanical part of the art of shading will be better explained by the drawing copied from, than by any directions, and much trouble will be saved by using the middle tint paper, but it should be remembered, that though black chalk can be used upon white paper, black-lead must be confined to it. The shadows are sometimes softened off by the stump,

yet clear hatched lines in the form abovementioned have a better effect, not that we would recommend the servile resemblance of an engraving, imitations of this description never failing to injure the freedom of hand, essential in drawing well.

It is necessary that the student should by no means depend upon his own judgment in selecting drawings or prints for copying, those of acknowledged excellence by or after the best masters are to be exclusively preferred, otherwise error would be perpetuated, and the arts would fall into irrecoverable contempt; he will soon see the necessity for this precaution, and learn to look with disgust upon deformity and mediocrity. Supposing the student perfect in his imitations of the different parts of the face, his next step will be to draw the head in every natural position, which forms an introduction to the whole figure, admitting him to have a competent knowledge of the human skeleton and the muscles, as those are the only branches of anatomy useful in drawing; to accomplish this, or confirm his ideas, he should attend lectures on that intricate science, confining his attention solely to the demonstrations and observations applicable to his pursuits, afterwards examining their effects as discoverable in a living subject, and in drawing either from that, or good plaster figures, he should begin with the most prominent muscles, which will facilitate his progress with the less.

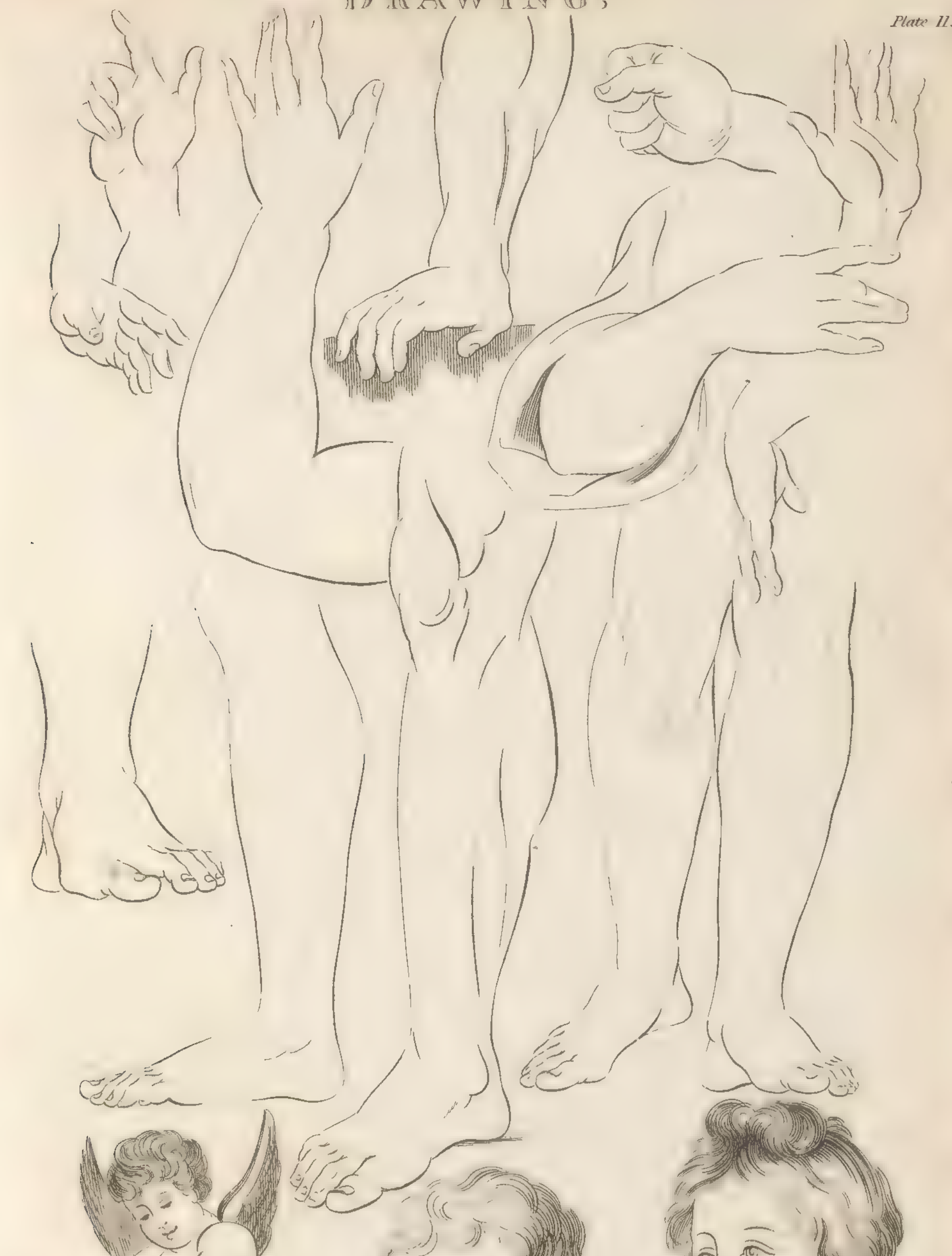
The young artist ought, if practicable, to visit the Royal Academy, where he will see, at a glance, how the light should be disposed to draw with effect; if that is impossible, he must remember to throw one light downward on the object, whether it proceeds from the day or a candle; and that he cannot too strictly attend to the true proportions of the body and limbs, as nothing is more disgusting than to see a man with a head unnaturally large, an enormous mouth, short legs, or too long arms; to prevent his falling into such errors, let him observe, that in a well-formed person, his arms extended make a distance between the extremities of the middle fingers equal to his length; that the face consists of three exact divisions, from the hair on the forehead to the eyes, from the eyes to the bottom of the nose, and from that to the chin. The whole figure is ten faces in length; from the chin to the collar-bone is twice the length of the nose, thence to the lowest part of the breast one face, from that to the navel another, to the groin one, to the upper part of the knee two, the knee is half a face in length, from the lower part of which to the ancle is two faces, and hence to the sole of the foot is one half. Measuring from the extremes of the breast, the breadth will be found to contain two faces, and the bone of the arm from the shoulder to the elbow, the same number; thence, including part of the hand, two faces; and from the shoulder-blade to the hollow between the collar-bones, is one face. The thumb is the length of the nose; from the commencement of the hand to the middle of the arm is five lengths of the nose; and from the pectoral muscle to the same place is four. The great toe is of the length of the nose, and the sole of the foot is the sixth part of the length of the figure; the hands are double their breadth in length, and when extended they are exactly the length of the face. The breadth of the limbs vary according to the state of health in the body, and the particular situation of the muscles whenever moved.

The proportions of children are generally thus: three heads in length from the crown of the head to the groin, and thence to the sole of the foot two, one head and a half between the shoulders, one, of the body between the hips and armpits; the breadth of the limbs should be ascertained from a healthy child.

It is perhaps impossible to draw a perfectly beautiful figure from any one person: the most skilful statuaries and painters, sensible of this fact, have composed their finest works from different subjects, as it is very common for the possessor of a truly Grecian head to have a deformed trunk, or another to have graceful limbs and the face of a gorgon. To draw a figure correctly, the intended length should be marked, and all the preceding admeasurements strictly adhered to, beginning the sketch on the left hand, with the head, following with the shoulders, the trunk, the leg most in action, then the other, finishing with the arms, and making the outline perfect before any part is finished; as we may imagine a living or plaster model placed before the student, that will serve better for improving him than any written instructions, but he will find the greatest difficulty in correctly copying the eyes, mouth, ears, hands, and feet, and should consequently be particularly careful when employed on those parts to which rules are utterly inapplicable.

To represent the passions well, every possible attention must be paid to their par-

Plate II.



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Cooper sculp.

ticular influence on the muscular system, certain determinate attitudes follow each sensation of the soul, and it is the muscles which express their energy; in sleeping or quiescent bodies, they are not obtruded on the view, but when their action is excited by some pleasing or horrible cause, they become tense, or relax, and are partially very prominent; the laocoon, and several of the single figures of gladiators, are good studies for the muscles; indeed the modern brethren of the latter, of pugilistic celebrity, might afford many useful hints of manly exertion: it should be recollected, that the most violent emotions of the female sex do not produce the same appearances in their muscles as is observable from similar causes in men, it would therefore be very improper to shew them as prominently; in addition, persons in the lower ranks of life ought to be represented more muscular than the members of the highest orders of the community. (See article Muscles in ANATOMY).

Drawing of Drapery follows: in this particular we are in a great measure compelled to have recourse to the ancients, as however convenient our modern habits may be, they are decidedly ungraceful opposites to the tasteful clothing of antiquity; for this reason every beautiful example from that pure source ought to be studied, carefully distinguishing the light, airy dresses of the heathen deities, and angels, of more recent conception, and their almost transparent folds clinging through motion to their forms, from those intended expressly to cover nakedness, and preserve the person from the ill effects of cold air, observing, besides, the particular shapes of garments, characteristic of the Jewish, Grecian, or Roman nations.

Many statuaries have erred in representing their figures as if clothed in wet linen, in order to shew the contour of the limbs to greater perfection; but this absurdity carries its own condemnation with it. It must be obvious to the most superficial observer, that the texture of drapery should be suited to the inner or outward habit, and its richness, or the reverse, to the situation of the party represented: to determine this point with accuracy, it will be proper to read such works as describe the official and other habits of ancient times, and compare their descriptions with antique statues and paintings; the ornaments and insignia of the rich and powerful may be known by the same means.

In drawing of fine linen, the folds should be made delicate, inclined to angles, and numerous or otherwise, according to the disposition of the habit on the body, where it is confined by a girdle or broach, they are multiplied and in lines, but those should neither be parallel nor disposed like rays: the reflected and transparent lights are particularly pleasing in this material, nor are the shades ever deep and harsh. In clothes made of wool, care must be taken to shew it fine on the rich, and coarse on the poor; in either case the folds should be large, and by no means numerous, partly cylindrical in their form, sometimes angular, and at others waved, the lights must not be very strong, but the shades deep, and the reflected lights faint, if the colour of the dye is dark. Silks fall into the least graceful folds of any material used in clothing, it will be best, therefore, to draw them from reality, endeavouring to catch the most natural, and copying with great attention the brilliant edges which are their characteristics, and the numerous reflections occasioned by the gloss on the inferior projections. Jewels and ornaments of gold, embroidery, &c. will at times be useful, but there are no rules applicable to the drawing of them. In the general disposition of the drapery, the posture of the figure and of the limbs must uniformly be consulted, they must accord, or there can be no other effect than stiffness in the person represented. Drapery gently agitated by the wind, in running or flying figures, has a good effect when it is made to flow in one direction, and not too much extended; the lights require great care, and should be directed on the most rotund parts, and those must not be crossed by dark shade, or the limbs or body so treated will appear broken.

Lest it should be supposed, the foregoing rules are rather calculated for a person in some degree acquainted with the art of drawing, than one beginning with the first rudiments, we shall descend to still further minutiæ.

When a picture highly varnished, a drawing in brilliant colours, or glazed print, is to be copied, it should be placed in a reclining position, that the light may not glare on it and confuse the eye; if the painting is large, the distance should be proportionably increased, so as to enable the copyist to see the whole at once. After marking the spaces between the features, and the different parts of the body, the outlines must be faintly sketched, and if the subject con-

tains several figures, it will be proper to find the centre and mark it, which will give the learner an opportunity of ascertaining the places of the most conspicuous correctly on either side. Having completed the outline, it must be critically examined, and amended where faulty, ere the least attempt be made at finishing. If a print is to be imitated, the lines which compose it are to be followed in every particular with a good pen and Indian ink, as an engraving supersedes all directions.

There are several useful rules to be observed in drawing a truly proportioned head and face: the former contains four equal parts, measuring from the crown to the upper part of the forehead, to the eye-brows, to the lower part of the nose, and to the chin. The first step towards drawing a full face is to form an oval, through which make a perpendicular line, and a second across the centre, then divide the former into four equal parts, the first is to include the hair, the second the forehead, the third the nose, and the last the lips and chin; the transverse line is to be considered five times the length of the eye, one length of which is to be left for the space between the organs of sight; the ear should never be higher than the eye-brows, nor lower than the bottom of the nose; the mouth is the length of the eye, and the middle of it must be on the perpendicular line, and the exterior of the nostrils ought not to extend beyond the inner corner of the eyes. To illustrate the above directions practically, they may be followed on an oval of wood made for the purpose, which when turned sideways, upwards, or downwards, will shew the true lines of the face in those positions. See PLATES—DRAWING. In drawing the profile, the line of the oval is still to be preserved, but the projections of the nose, &c. must be left to the learner's observations on living figures. It has been observed by an eminent painter, that nothing is more easy than to represent an infant smiling, or under the influence of grief, which is accomplished by raising the corners of the mouth in the first case, and depressing them in the second; in smiling, the eyebrows undergo but little alteration; but in frowning they are violently contracted, and drawn towards each other. In other parts of the figure, care should be taken to avoid shewing the muscles too strong, even in representing large persons; in youth they are less visible, and in corpulent figures they are almost concealed from view. In the breadth of the limbs it will be found, that the calf of the leg is double the diameter of the ancle, and that the largest part of the thigh is three times the diameter of the smallest.

Drawing of Landscapes. The science of perspective is so absolutely necessary in this branch of the art, that it must be acquired before the student attempts to copy a drawing or print; for although the heights of trees, bushes, hills, &c. &c. vary greatly, yet there is a general and palpable declension in the relative proportions as they retire from the eye; besides, if a building intervenes, the want of truth in this particular becomes instantly obvious.

When the student is master of perspective he may proceed to copy good drawings either with black-lead pencils or chalk, according to the paper he adopts; but he should prefer those only that give a clear and distinct idea of the outline, as he cannot possibly comprehend the forms of objects which are mixed and lost in others, merely to bring the light into a focus for brilliant effect: it would not be amiss at the same time to draw detached objects, till their forms are perfectly and correctly obtained; having accomplished this point, groupes will be more easily understood and copied. Shading with the above materials must be governed by the objects drawn from: in using Indian ink, the student should lay on the colour exceeding faint next the light, and deepen the shade gradually; and we would recommend him to confine himself to it till a good judge of his merit pronounces he may attempt colouring; as he should remember his aim is to become a skilful artist by regular progression, and not a mere gaudy colourist, to entrap vulgar applause. When the student arrives at this most difficult and arduous branch of the art, he cannot too attentively consult the best specimens of colouring within his reach, remarking how the tints of the air in the zenith are generally treated, which is of a purer blue than on the horizon, where the vapours, continually floating near the earth, become more visible, and are tinged with yellow or purple, according to the position of the sun, and their form, when condensed and raised in clouds, which partake of the same tints from the same cause, their transparency in some parts, their dazzling light, reflections, and deep shades, in others. He will perceive that the experienced artist, sensible of the existence of moisture in the air be-

DRAWING,

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tween him and the remotest objects, has shewn very distant hills obscured by blue, or faintly-purple vapours, which becoming less dense in nearer objects, are gradually made more perfect, till those in the front of the drawing exhibit a decided boundary, and clearly defined lights and shades. Contrary to Sir Isaac Newton's opinion, that the rays of the sun contained seven primitive colours, more modern philosophers insist there are but three, blue, red, and yellow; those must therefore serve as the grand basis in colouring, but as nature never glares in fierce tints, they should be tempered according to her dictates, and for the causes mentioned above. No one colour should prevail in a good landscape, neither should they be disposed in the prismatic form, but all parts ought to harmonize and give a pleasing aggregate. The colouring of objects in the fore-ground requires particular attention, as neither a wall, a bank, or a tree presents one uniform tint; on the contrary, the stones, or bricks, of which the first is composed, always differ from each other in colour; besides, the trickling of dews, the vegetation of different species of moss, the corroding effects of time and the weather, produce characteristic effects extremely picturesque; this is equally observable on wood; and the bark of trees, and banks present numerous tints in the sand, clay, and stones of which they are composed, exclusive of the variety of plants scattered on their surface. The walls of castles and of monasteries adorned with beautiful masses of ivy, the north sides of houses in damp situations, and trees, are excellent subjects for contemplation in this particular; indeed every substance in a state of decay seems to invite representation, by the beautiful properties they assume, which are still further observable as they become useless to the possessor. The peasant's house, in this instance, in complete ruins, with fallen bricks, or broken plastered sides, and almost without thatch, is more inviting to the artist than all the splendor of Grecian façades and magnificent porticos.

In composing a drawing, the best parts of various views from nature should be selected, always remembering that those parts should never resemble each other, and that none of their lines should be parallel; if nothing more is intended than a good composition, such are to be obtained from reality, by merely correcting little errors committed by nature; for instance, a stream of water may flow in nearly a straight line through a most beautiful district, yet, thus represented, it would have a bad effect in the drawing; equally disagreeable are two or three hills of similar outlines ranged beyond each other: to turn the stream into a more serpentine form, or change the outlines of the hills, will therefore be no deviation from propriety: it is far otherwise in making a view of any particular place for topographical purposes; in that case, the object to be attained is not an unexceptionable drawing, but a true representation even of deformity.

The best colours are those sold in boxes, properly mixed with gum, which rubbed on a tile, and diluted with water in the brush, flow readily, and are very clear: those commonly used will be found properly placed and named in the cases alluded to. Nothing will contribute more towards obtaining correctness in drawing than a free and unembarrassed conduct of the black-lead pencil and port-crayon, which should not be held too near the points, nor should the rule and compasses be employed, except in making admeasurements and drawings of architecture; when copying from any given subject, it will greatly expedite the progress to imagine the picture or drawing divided into squares, and the paper in an equal number; by this means the true situation of each figure, within these imaginary squares, may be transferred to the same imaginary squares on the paper. A more mechanical method to copy in the same size as the original, or to reduce or enlarge the copy, is to draw real lines across each, forming an equal number of exact squares, and numbering them throughout so as to correspond: threads stretched across a picture instead of lines must be less injurious to it, and ought to be preferred. The pentagraph is an useful instrument, invented for enlarging or reducing the outlines of pictures, drawings, prints, or plans, or copying them of the original size. In drawing from nature, much circumspection should be used in chusing the spot whence the view is to be seen, as a few feet or yards often makes an essential difference in the beauty of the groupes and individual objects; a gentle elevation should be preferred, whence the eye may embrace a large circumference; then fixing upon some certain points, imagine several perpendicular lines, and marking an equal number on the paper, let the horizontal line intersect them, the objects to be represented are thus ob-

tained as in the method of copying by squares. Every peculiarity of the landscape must be caught with avidity, the declination of lines, the apparent lessening of objects, the species of the trees, the tendency of the broken fragments on the edges of clouds, and the movements of the foliage and branches by the wind; the seasons should also be observed, as the lights vary greatly with them, and the colouring essentially. Raging billows, waterfalls, and clouds discharging rain, offer many particulars for minute observation, and the shadows of passing clouds have a beautiful effect when chasing each other over the sides of mountains, or are spread like a veil over a large tract of country. In making the lights and shades of a landscape, it must never be forgotten, that whatever place the sun may be in, the light can fall but one way, and that all the difference possible in the shades are their degrees of strength between morning, evening, and noon, and their strength at either extreme of the day compared with the meridian, as they are very short at that period, and often intermixed with strong reflected light, experienced artists always prefer morning and evening, as productive of those golden and purple tints which catch upon objects half buried in deep shadow, and give a beautiful effect to the landscape. Claude Lorrain was almost the only painter who thought himself equal to representing the sun, and the silvery effect of its beams, upon water: that he succeeded to admiration must be acknowledged, but it is extremely doubtful whether his pictures will ever be equalled; it is, however, certain, that the attempt has failed in every modern instance. As one step towards imitating the brilliancy of the orb of day, it has been the custom to suppose the sun just beyond the boundary of the picture, by making the sky clear and light on that side, and gradually fading thence through the landscape. As this method is founded upon just principles, the young artist may safely adopt it, though not as an indispensable rule; for the light breaking through clouds, and luminating the centre or front of a view, has an excellent effect, especially if that spot is animated by human figures or cattle. When a building, whether a modern or ancient edifice, is the principal object, the light should be thrown decidedly on it, though that on the sides of clouds next to the sun must be brightest. But as that may be considered too attractive of the attention from the building, the atmosphere ought to be rather dark and tempestuous; because, if there are few clouds, the light distributed on the globules of moisture floating in the air will overpower even the direct rays of the sun on an opaque body. In shading circular bodies, the light side ought not to cut hard upon the next object, but be softened into it in a slight degree; the brightest light succeeds, then the shading gradually deepens about three quarters through, after which the extremity catches a reflected light, and the outline blends with the tint behind it; in the same manner foliage, the edges of hills, &c. should combine with the light or shade behind them. In representing the angles of houses, the strongest shades must be next the light, whence they decline and become lighter: in this case, and in every particular relating to architecture, it will be most proper to draw from the works of the best masters, and finally from reality, as it is almost impossible to describe the consequence of every little light, and shade projected from the ornaments. Contrast, when artfully contrived, is the true secret of producing relief; for instance, a plain light surface will not relieve from the paper; but if the same surface has part of its depth shaded, as if placed obliquely, it assumes solidity: thus, if two deeply darkened objects are connected, they will appear on the same line; but if a faint light, derived by reflection from some neighbouring substance, is thrown upon the most distant, it will detach itself, and give an idea of separation from the other: hence it follows, that shade should always be opposed to light throughout a landscape, but in that judicious manner pointed out by nature, whose operations in this case must be closely examined and ascertained, as they are often so faintly and capriciously performed as to elude an eye unaccustomed to accurate observation: let it be remembered, besides, that her contrasts are never violent and glaring, ever declining in force with the distance of the objects; those in the front of a view require the most attention, as every part being near, they become perfectly distinct, and must be represented with the strongest colours suited to the substance.

There are some other rules proper in drawing; particularly, if a flower is to be copied from nature, it is usual to begin with the centre, proceeding thence with the leaves composing it to the extremities, which method enables the student to lay them one above another in the correct and

beautiful manner they are disposed by the Great Author of all things. In colouring those fascinating objects, infinite skill is required in blending their tints so as to keep each clear and bright. In observing birds, it will be found that the feathers of the head are smallest, whence they proceed to the tail in five ranges. In this instance, and in drawing animals, every precaution cannot be too closely attended to, which will give their true characteristics.

Having completed the necessary instructions for drawing, by the improvement of a native genius, or inclination for the study of the fine arts, which is known to be inherent in some, and utterly unknown to the majority of mankind, we shall next notice what may be termed

Mechanical drawing, which is indispensable in many pursuits, and amusing to all whose time might be less profitably employed. To draw plans, maps, and figures of new inventions well, geometry and perspective must be thoroughly understood, particularly if elevations and sections of buildings are attempted: to proceed regularly, the free use of the black pencil ought to be attained, after which the use of Indian ink with a fine pen should be acquired, with a facility of drawing lines either with or without a ruler, particularly curves beyond the range of a small compass: to those are to be added the doctrines of light, shade, and reflection, and an easy, careless method of shading, which is readily accomplished if instruments of any kind are to be copied, as they may be placed in the most favourable light at pleasure. Taste is out of the question in this branch of the art, merely suited to the architect, the philosopher or mathematician, and the geographer. Young ladies of fortune, and persons fond of pleasant employment, may derive information from the following modes of proceeding in copying, tracing, &c. &c.

Tracing paper is readily made by taking a sheet of very thin silk, or other paper, and rubbing it over gently with some soft substance, filled with a mixture of equal parts of drying oil and oil of turpentine, which suspended and dried will be fit for use in a few days, or it may be had at any of the colour shops. Lay this transparent material on the print or drawing to be transferred, and with a sharp black lead pencil trace the outlines exactly as they appear through the paper. If more permanent or stronger lines are wished, ink mixed with ox-gall will be necessary to make it adhere to the oiled surface.

Tracing against the light: there are two methods; one to lay the print, &c. flat against a pane of glass, with thin paper over it, when the lines appearing through it are to be followed by the lead: the other is more convenient, and consists of a frame inclosing a square of glass, supported by legs, on which the paper is laid as before, and a candle placed behind the glass. A pen and ink may be used in this manner, but they cannot in the former instance.

Another method of using transparent paper. Take a piece of the size required, and rub it equally over on one side with black-lead reduced to a powder, till the surface will not readily soil a finger, then lay a piece of white paper with the blacked paper, and leaded side next to it, under the print, and securing them firmly together with pins at the corners, proceed to trace the outlines with a blunt point, and some degree of pressure, which will transfer the lead to the clean paper precisely in the direction the point passed over the print: this may be corrected with the black-lead pencil, and cleansed of any soil by the crumbs of stale bread.

Copying drawings, &c. with fixed materials. Rub a thin piece of paper thoroughly and equally with fresh butter, and after drying it well by a fire, cover it with black-lead, as before mentioned, or with carmine, lamp-black, or blue-bice, on the side which received the butter. When the operation has so far succeeded, as that the colour will not adhere to any substance passed over it, lay the coloured surface on white paper, the print on it, and trace the subject through with a point as above.

To transfer any impression with vermillion. Mix the colour with linseed oil in a state sufficiently fluid to flow from the point of a pen, with which let every line of the print be accurately traced; then wet the back of it, and turning the face downwards on clean white dry paper, place other paper on the back, and gently rub or press it, till it may be supposed the red lines are completely transferred to the paper from the print.

Writing, or outlines of prints, may be conveyed exactly by the following method. Mix fine vermillion with water, of the same fluidity as ink, and putting it into a vessel containing cotton, use it with a pen in tracing over the subject, making the lines of the same breadth as the original; then wet

white paper with gum-water spread by a sponge, and lay the vermillion tracing on it gently, pressing every part till the process is complete: when the print is withdrawn the gum will retain the vermilion, and after it is dried they will become inseparable. This mode, except the gum and paper, is used by engravers, who secure the lines by wax on their copperplates.

There are numerous beauties in the skeletons or fibres of leaves; and it is at least a pleasing, if not an useful employment to collect all, or a part of their varieties, which may be done with decisive accuracy as follows.

To obtain the true shape and fibres of a leaf, rub the back of it gently with any hard substance, so as to bruise the fibres, then apply a small quantity of linseed oil to their edges; after which press the leaf on white paper, and, upon removing it, a perfectly correct representation of every ramification will appear, and the whole may be coloured from the original.

Another way, which may be called printing of a leaf. This is effected by carefully touching the fibres with one of those balls lightly covered with ink used by printers, and impressing it on wet paper. This is done to most advantage by a round stick covered with woollen cloth, rolled backwards and forwards over the paper and leaf.

A substitute may be adopted by rubbing and bruising the leaf, oiling it as before, and scattering powdered black lead, charcoal, or the powder of burnt cork on it, and pressing it on paper. Other colours may be used, prepared with butter or oil, of which blue-bice is the best, as it serves as a ground for colouring the leaf from nature. The back of the leaf must be exclusively preferred, as the fibres project on that side only.

Stenciling is a process well calculated for multiplying of patterns, for working in muslin, &c.; when a print or drawing is to be copied in this way, it must be placed upon a sheet of white paper, and the outline pricked through both with a pin or needle; the pierced sheet may then be laid on a second clean one, and a muslin bag of powdered charcoal shaken or rubbed over it, when, upon removing the former, the latter will be found a perfect copy.

The camera obscura makes the most pleasing representation of nature hitherto discovered, by which the external objects are reflected on any plane within the chamber in the liveliest colours, and every leaf and animal appear in motion; but unfortunately in a reversed position. The constructing of a camera obscura is a very simple operation: close all the windows of an apartment, and leave a single circular aperture suited for the reception of a convex or plane convex lens in the shutter of that which faces the greatest variety of landscape; then place any smooth white surface before it, at the proper distance, which is to be determined upon the same principle as the movement of the glasses of a telescope, and every portion of the view will be exhibited on it. If the least ray of light makes its way through any other means, the effect will be destroyed; and it will be heightened if the atmosphere is clear and the sun shines bright.

The portable camera obscura resembles a wooden box or chest, furnished with a circular or angular projection in the middle, opening from it and to be directed towards the landscape; beyond this aperture, and within the box, is placed a small mirror inclined to an angle of 45 degrees, serving to reflect the exterior rays on a convex lens set in a tube, and the light streaming from this will convey the true forms and colours of the landscape to a paper situated at the proper distance to receive them; this beautiful picture is viewed through an oblong aperture, and may be copied with equal facility and advantage; indeed the most experienced artist may obtain hints from the camera obscura, which might escape his notice in drawing directly from reality. The literally darkened chamber furnishes the means of improvement, though some little contrivance is necessary to use them conveniently, and obviate the unpleasant circumstances attending the drawing of reversed objects; it may, however, be recollected, that any thing drawn in this position will become right on turning the paper; or the person desirous of so doing may place the paper on some low article of furniture, and standing over it, view every part in its proper state; but the portable camera obscura, being expressly intended for making of correct drawings, should be preferred, as it affords a horizontal plane for the hand to rest on conveniently.

Transparencies were not long since extremely fashionable, as blinds for windows, and substitutes for painted glass; indeed authors and artists have been known to venture quarto volumes on the subject. Their effect is certainly pleasing, when the lights

are clear and brilliant, and the shades judiciously contrasted with them; but those, like every product of the fine arts under the same circumstances, become contemptible when incorrectly executed. The choice of the subject is of great importance in each branch of drawing, and none more so than those for transparencies, for which moon-light and fire-light scenes are generally adapted, as both are capable of producing great richness in the tints, and when introduced with ruins, are more particularly attractive: for instance, the court of an ancient feudal castle, surrounded by fragments of walls, pierced with windows of magnificent mould, through which the foliage of the ivy hangs in grand festoons, grouping with the aspiring ash, the branches of the latter silvered by moon-light, gleaming between various towers retiring each beyond the other, and waving over the deep shades of the former, at the same time faintly illuminating the gliding figures of midnight plunderers, seen passing through the gateway.

Having excited attention to the nature of the best subjects, it will be necessary to say how they should be treated. Fix the paper intended for this purpose in a straining frame, draw the design, and colour it in the usual manner, then placing it against a window, examine where the shades require strengthening, which will be sometimes necessary on the back of the drawing, and with the opaque substances of ivory or lamp-black, mixed with gum water; having completed it to the due effect, the brightest parts, as the moon or a fire, are to be impregnated with spirits of turpentine on each side of the paper, and the next lights on one side only; those must be covered again with a varnish, composed of two equal portions of spirits of turpentine and Canada balsam, but with great care lest it spread beyond the desired limits. The moon must not be coloured, but fire and flame will require red lead and gamboge.

There is one other process which will be entertaining to a studious mind, destitute of any particular partiality for the arts, which is preparing a sheet of thin white-brown paper, by passing a brush over it filled with oil of turpentine; thus made transparent, it is to be strained upon a frame, and placed against any object that may be preferred, then take a perforated board suited to the eye, and looking through it draw the outline observable on the transparent paper with a black-lead pencil; the shading of the object may be obtained very correctly by this means, with a little attention; but it should be done rapidly as the position of the shadows continually vary with the motion of the sun: to facilitate this part of the operation it would be well to make several degrees of colour, and number them as they appear on the paper, in order to finish the drawing at more leisure.

Drawing *a cast*, among bowlers, is winning the end, without stirring the bowl or block.

Drawing, *fine*, among taylors, the art of sowing up button-holes, or any rents in cloth, in so nice a manner as that they cannot be discovered from the entire part of the cloth.

DREAMS have been described as the imaginations, fancies, or reveries of a sleeping man, and they are said to be deducible to the three following causes: 1. The impressions and ideas lately received, and particularly those of the preceding day. 2. The state of the body, particularly the stomach and brain; and, 3. Association. That dreams are, in part, deducible from the impressions and ideas of the preceding day, appears from the frequent recurrence of these, especially of the visible ones, in our dreams: in general, ideas that have not affected the mind for some days, recur in dreams only from the second and third causes. That the state of the body affects our dreams, is evident from the dreams of the sick, and of those who labour under indigestions, spasms, and flatulencies; and a little observation will shew that we are carried on from one thing to another in our dreams partly by association. In proof of what we have advanced, we may observe, 1st. That the scenes which present themselves in dreams are taken to be real, and we suppose ourselves present, and actually seeing and hearing what passes, which is occasioned by there being no other reality to oppose to the ideas which offer themselves, whereas in the common fictions of the fancy, while we are awake, there is always a set of real external objects striking some of our senses, and precluding a like mistake there. Again, the trains of visible ideas, which occur in dreams, are far more vivid than common visible ideas, and may therefore be more easily taken for actual impressions. 2dly. There is a great wildness in our dreams; for the brain, during sleep, is in a state so different from that in which the usual associations were formed,

that they can by no means take place during vigilance. The state of the body suggests such ideas among those that have lately been impressed, as are more suitable to various kinds and degrees of pleasant and painful emotions excited in the stomach, brain, or other part. Thus a person who has taken opium, sees either gay scenes or ghastly ones, according as the opium excites pleasant or painful sensations in the stomach. Hence it will follow, that ideas will rise successively in dreams, which have no such connection as take place in nature, in actual impressions, nor any such as is deducible from association; and yet, if they rise up quickly and vividly, one after another, as subjects predicates, and other associates use to do, they will be affirmed of each other, and appear to hang together. Thus the same person appears in two places at the same time; two persons appearing successively in the same place, coalesce into one; a brute is supposed to speak, any idea, qualification, office, &c. coinciding in the instant of time with the idea of one's self, or of another person, adheres immediately, &c. &c. 3dly. We do not take notice of, or are offended at, these inconsistencies, but pass on from one to another. For the associations, which should lead us thus to take notice, and be offended, are, as it were asleep; the bodily causes also hurrying us on to other and new trains successively. But if the bodily state be such as favours ideas of anxiety and perplexity, then the inconsistency, and apparent impossibility, occurring in dreams, are apt to give great disturbance and uneasiness. It is to be observed likewise, that we forget the several parts of our dreams very fast in passing from one to another; and that this lessens the apparent inconsistencies, and their influences. 4thly, It is common in dreams for persons to appear to themselves to be transferred from one place to another, by a kind of sailing or flying motion. This arises from the change of the apparent magnitude and position of the images excited in the brain, this change being such as a change of distance and position in ourselves would have occasioned. Whatever the reasons be, for which visible images are excited in sleep, like to the objects with which we converse when awake, the same reasons will hold for changes of apparent magnitude and position also; and these changes, in fixed objects, being constantly associated with motions in ourselves when awake, will infer these motions when asleep. But then we cannot have the idea of the *vis inertiæ* of our own bodies, answering to the impressions in walking; because the nerves of the muscles either do not admit of such miniature vibrations in sleep; or do not transmit ideas to the mind in consequence thereof; whence we appear to sail, fly, or ride. Yet sometimes a person seems to walk, and even to strike, just as in other cases he seems to feel the impression of a foreign body on his skin. 5thly, Dreams consist chiefly of visible imagery. This agrees remarkably with the perpetual impressions made upon the optic nerves and corresponding parts of the brain during vigilance, and with the distinctness and vividness of the images impressed. 6thly, It may be observed that many of the things which are presented in dreams, appear to be remembered by us, or, at least, as familiar to us; and that this may be solved by the readiness with which they start up, and succeed one another in the fancy. 7thly, Dreams ought to be soon forgotten, as they are in fact; because the state of the brain suffers great changes in passing from sleep to vigilance. The wildness and inconsistency of our dreams render them still more liable to be forgotten. It is said, that a man may remember his dreams best by continuing in the same posture in which he dreamt, which, if true, would be a remarkable confirmation of the doctrine of vibrations; since those which take place in the medullary substance of the brain, would be least disturbed and obliterated by this means. 8thly, The dreams which are presented in the first part of the night are, for the most part, much more confused, irregular, and difficult to be remembered, than those which we dream towards the morning; and these last are often rational to a considerable degree, and regulated according to the usual course of our associations. For the brain begins then to approach to the state of vigilance, or that in which the usual associations were formed and cemented. However, association has some power even in wild and inconsistent dreams.

DREIN, in the military art, a trench made to draw the water out of a moat, which is afterwards filled with hurdles and earth, or with fascines, or bundles of rushes and planks, to facilitate the passage over the mud.

DRESSING *of ores*, the breaking and powdering them in the stamping mill, and afterwards washing them in a wooden trough.

Dressing, in surgery, the treatment of a wound or any disordered part. The apparatus of dressing consists of dossils, tents, plasters, compresses, bandages, bands, ligatures, and strings.

DRIFT, in naval language, the angle which the line of a ship's motion makes with the nearest meridian, when she drives with her side to the wind and waves, and is not governed by the power of the helm. It also implies the distance which the ship drives on that line. A ship's way is only called drift in a storm, and then when it blows so vehemently as to prevent her from carrying any sail, or at least restrain her to such a portion of sail as may be necessary to keep her sufficiently inclined to one side, that she may not be dismasted by her violent labouring, produced by the turbulence of the sea.

DRILL, in mechanics, a small instrument for making such holes as punches will not conveniently serve for. Drills are of various sizes, and are chiefly used by smiths and turners.

Drill, or Drill-box, a name given to an instrument for sowing land in the new method of horse-hoeing husbandry. It plants the corn in rows, makes the channels, sows the seeds in them, and covers them with earth when sown; and all this at the same time, and with great expedition. The principal parts are the seed-box, the hopper, the plough and its harrow, of all which the seed-box is the chief. It measures, or rather numbers, out the seeds which it receives from the hopper, and is for this purpose as an artificial hand; but it delivers out the seed much more equally than can be done by a natural hand. See Agriculture.

DRINK, a part of our ordinary food in a liquid form, serving to dilute and moisten the dry meat. See Dietetics.

DRIVING, in the sea language, is said of a ship when an anchor being let fall will not hold her fast, nor prevent her sailing away with the tide or wind. The best help in this case is to let fall more anchors, or to veer out more cable; for the more cable she has out, the safer she rides. When a ship is a-hull or a-try, they say she drives to leeward.

DRONE, in the history of insects, a kind of bee, larger than the common working or honey bees: it is so called from its idleness, as never going abroad to collect either honey or wax. See Apis.

Drone, in music, the largest tube of the bag-pipe; the office of which is to emit one continued deep note, as an accompanying bass to the air or tune played on the smaller pipes.

DROPS, in meteorology, small spherical bodies which the particles of fluids spontaneously form themselves into, when let fall from any height. This spherical figure, the Newtonian philosophers demonstrate to be the effect of corpuscular attraction, for considering that the attractive force of one single particle of a fluid is equally exerted to an equal distance, it must follow that other fluid particles are on every side drawn to it, and will therefore take their places at an equal distance from it, and consequently form a round superficies.

Drops, in medicine, a liquid remedy, the dose of which is estimated by a certain number of drops.

DROPSY, in medicine, an unnatural collection of watery humours in any part of the body. See Medicine.

DROSERA, in botany, a genus of the Pentandria Pentagynia class and order. Natural order of Gruinales. Capparides, Jussieu. Essential character: calyx five-cleft; petals five; capsule one-celled, five or three valved at the tip; seeds very many. There are nine species. These are herbs of a small size, and singular structure. The leaves in most of the species near the root, are furnished with glandulous hairs on the upper surface, and fringed round the edge; these hairs have each a small globule of a pellucid liquor like dew, continuing even in the hottest part of the day, and in the fullest exposure to the sun. Hence their English name of sundew. D. acaulis is singular for having a sessile flower in the bosom of the root leaves. These plants have the property of entrapping small insects within their folded leaves. It was discovered by Mr. Whately, a surgeon. On inspecting some of the contracted leaves, he observed a fly in close imprisonment; and on centrically pressing other leaves. yet in their expanded form, with a pin, he observed a sudden elastic spring of them, so as to become inverted upwards, and as it were encircling the pin.

DROWNING, signifies the extinction of life, by a total immersion in water. In some respects there seems to be a great similarity between the death occasioned by immersion in water, and that by strangulation, suffocation by fixed air, apoplexies, epilepsies, sudden fainting, violent shocks of electricity, or even violent falls and

bruises. Physicians, however, are not agreed with regard to the nature of the injury done to the animal system in any or all of these accidents. It is, indeed, certain, that in all the cases above mentioned, particularly in drowning, there is very often such a suspension of the vital powers as to us hath the appearance of a total extinction of them; while yet they may be again set in motion, and the person restored to life, after a much longer submersion than hath been generally thought capable of producing absolute death. It were to be wished, however, that, as it is now universally allowed, that drowning is only a suspension of the action of the vital powers, physicians could as unanimously determine the means by which these powers are suspended; because on a knowledge of these means the methods to be used for recovering persons apparently drowned must certainly depend. We shall, in this place, give some directions on the subject, which have been recommended on respectable authority, and have been sanctioned by long experience.

Mr. Hunter observes, that when assistance is soon called after immersion, blowing air into the lungs will, in some cases, effect a recovery; but when any considerable time has been lost, he advises stimulant medicines, such as the vapour of volatile alkali, to be mixed with the air; which may easily be done, by holding spirits of hartshorn in a cup under the receiver of the bellows. And as applications of this kind to the olfactory nerves tend greatly to rouze the living principle, and put the muscles of respiration into action, it may probably, therefore, be most proper to have air impregnated in that manner thrown in by the nose. To prevent the stomach and intestines from being too much distended by the air so injected, the larynx is directed to be gently pressed against the œsophagus and spine. While this business is going on, an assistant should prepare bed clothes, carefully brought to a proper degree of heat. Heat our author considers as congenial with the living principle; increasing the necessity of action, it increases action; cold, on the other hand, lessens the necessity, and, of course, the action is diminished: to a due degree of heat, therefore, the living principle, he thinks, owes its vigour. From experiments, he says, it appears to be a law in animal bodies, that the degree of heat should bear a proportion to the quantity of life; as life is weakened, this proportion requires great accuracy, while greater powers of life allow it greater latitudes. After these and several other observations on the same subject, our author proceeds to more particular directions for the management of drowned people. If bed clothes are put over the person, so as scarce to touch him, steams of volatile alkali, or of warm balsams, may be thrown in, so as to come in contact with many parts of the body. And it might probably be advantageous, Mr. Hunter observes, to have steams of the same kind conveyed into the stomach. This, we are told, may be done by a hollow bougie and a syringe: but the operation should be very speedily performed, as the instrument, by continuing long in the mouth, might produce sickness, which our author says he would always wish to avoid. Some of the warm stimulating substances, such as juice of horseradish, peppermint-water, and spirits of hartshorn, are directed to be thrown into the stomach in a fluid state, as also to be injected by the anus. Motion, possibly, may be of service; it may, at least, be tried; but as it hath less effect than any other of the usually prescribed stimuli, it is directed to be the last part of the process. The same care in the operator, in regulating the proportion of every one of these means, is here directed, as was formerly given for the application of heat. For every one of them, our author observes, may possibly have the same property of destroying entirely the feeble action which they have excited if administered in too great a quantity: instead, therefore, of increasing and hastening the operations on the first signs of returning life being observed, as is usually done, he desires they may be lessened, and advises their increase to be afterwards proportioned, as nearly as possible, to the quantity of powers as they arise. When the heart begins to move, the application of air to the lungs should be lessened, that, when the muscles of respiration begin to act, a good deal may be left for them to do.

Mr. Hunter absolutely forbids blood-letting in all such cases; for as it not only weakens the animal principle, but lessens life itself; it must consequently, he observes, lessen both the powers and dispositions to action. For the same reason he is against introducing any thing into the stomach that might produce sickness or vomiting; and, on the same principle, he says, we should avoid throwing tobacco fumes, or any other such articles up by the anus, as might tend to

an evacuation that way. The following is a description of instruments recommended for such operations, by our author. First, A pair of bellows, so contrived with two separate cavities, that, by opening them when applied to the nostrils or mouth of a patient, one cavity will be filled with common air, and the other with air sucked out from the lungs, and by shutting them again, the common air will be thrown into the lungs, and that sucked out of the lungs discharged into the room. The pipe of these should be flexible; in length a foot, or a foot and a half, and at least three eighths of an inch in width. By this the artificial breathing may be continued while the other operations, the application of the stimuli to the stomach excepted, are going on, which could not be conveniently done if the muzzle of the bellows were introduced into the nose. The end next the nose should be double, and applied to both nostrils. Secondly, A syringe, with a hollow bougie, or flexible catheter, of sufficient length to go into the stomach, and convey any stimulating matter into it, without affecting the lungs. Thirdly, A pair of small bellows, such as are commonly used in throwing fumes of tobacco up by the anus.

Within these few years great numbers of drowned people have been restored to life by a proper use of the remedies we have enumerated, and societies for the recovery of drowned persons have been instituted in different places. The first society of this kind was instituted in Holland, where, from the great abundance of canals and inland seas, the inhabitants are particularly exposed to accidents by water. In a very few years 150 persons were saved from death by this society; and many of these had continued upwards of an hour without any signs of life, after they had been taken out of the water. The society was instituted at Amsterdam in 1767, and, by an advertisement, informed the inhabitants of the United Provinces of the methods proper to be used on such occasions; offering rewards at the same time to those who should, with or without success, use those methods for recovering persons drowned and seemingly dead. The laudable and humane example of the Dutch was followed in the year 1768, by the magistrates of health in Milan and Venice; afterwards by the magistrates of Hamburgh, in the year 1771; by those of Paris, in the year 1772; and by the magistrates of London in 1774.

The following directions are given for the recovery of drowned persons by the society at London: 1. As soon as the patient is taken out of the water, the wet clothes, if the person is not naked at the time of the accident, should be taken off with all possible expedition on the spot (unless some convenient house be very near), and a great coat or two, or some blankets if convenient, should be wrapped round the body. 2. The patient is to be thus carefully conveyed in the arms of three or four men, or on a bier, to the nearest public or other house, where a good fire, if in the winter season, and a warm bed, can be made ready for its reception. As the body is conveying to this place, a great attention is to be paid to the position of the head; it must be kept supported in a natural and easy posture, not suffered to hang down. 3. In cold or moist weather, the patient is to be laid on a mattrass or bed before the fire, but not too near, or in a moderately heated room; in warm and sultry weather on a bed only. The body is then to be wrapped as expeditiously as possible with a blanket, and thoroughly dried with warm coarse cloths or flannels. 4. In summer or sultry weather too much air cannot be admitted. For this reason it will be necessary to set open the windows and doors, as cool refreshing air is of the greatest importance in the process of resuscitation.—5. Not more than six persons are to be present to apply the proper means; a greater number will be useless, and may retard, or totally prevent, the restoration of life, by rendering the air of the apartment unwholesome. It will be necessary, therefore, to request the absence of those who attend merely from motives of curiosity. 6. It will be proper for one of the assistants, with a pair of bellows of the common size, applying the pipe a little way up one nostril, to blow with some force, in order to introduce air into the lungs; at the same time the other nostril and the mouth are to be closed by another assistant, whilst a third person gently presses the chest with his hands, after the lungs are observed to be inflated. By pursuing this process, the noxious and stagnant vapours will be expelled, and natural breathing imitated. If the pipe of the bellows be too large, the air may be blown in at the mouth, the nostrils at the same time being closed, so that it may not escape that way: but the lungs are more easily filled, and natural breathing better imitated, by blowing up the nostril. 7. Let the body be gently rubbed with

common salt, or with flannels, sprinkled with spirits, as rum or geneva. A warming pan heated (the body being surrounded with flannel) may be lightly moved up and down the back. Fomentations of hot brandy are to be applied to the pit of the stomach, loins, &c. and often renewed. Bottles filled with hot water, heated tiles covered with flannel, or hot bricks, may be efficaciously applied to the soles of the feet, palms of the hands, and other parts of the body. The temples may be rubbed with spirits of hartshorn, and the nostrils now and then tickled with a feather; and snuff, or *eau de luce*, should be occasionally applied. 8. Tobacco fumes should be thrown up the fundament: if a fumigator be not at hand, the common pipe may answer the purpose. The operation should be frequently performed, as it is of importance; for the good effects of this process have been experienced in a variety of instances of suspended animation. But should the application of tobacco smoke in this way not be immediately convenient, or other impediments arise, clysters of this herb, or other acrid infusions with salt, &c. may be thrown up with advantage. 9. When these means have been employed a considerable time without success, and any brewhouse or warm bath can be readily obtained, the body should be carefully conveyed to such a place, and remain in the bath, or surrounded with warm grains, for three or four hours. If a child has been drowned, its body should be wiped perfectly dry, and immediately placed in bed between two healthy persons. The salutary effects of the natural vital warmth, conveyed in this manner, have been proved in a variety of successful cases. 10. While the various methods of treatment are employed, the body is to be well shaken every ten minutes, in order to render the process of animation more certainly successful; and children in particular, are to be much agitated, by taking hold of their legs and arms, frequently and for a continuance of time. In various instances agitation has forwarded the recovery of boys who have been drowned, and continued for a considerable time apparently dead. 11. If there be any signs of returning life, such as sighing, gasping, or convulsive motions, a spoonful of any warm liquid may be administered; and if the act of swallowing is returned, then a cordial of warm brandy or wine may be given in small quantities, and frequently repeated.

DRUG, a general term for goods of the druggist and grocery kinds, especially for those used in medicine and dying.

DRUGGET, in commerce, a stuff sometimes all wool, and sometimes half wool half thread, sometimes corded, but usually plain. Those that have the woof of wool, and the warp of thread, are called threaded druggets; and those wrought with the shuttle on a loom of four marches, as the serges of Beauvois, and other like stuffs, corded, are called corded druggets. As to the plain, they are wrought on a loom of two marches, with the shuttle, in the same manner as cloth, camlets, and other like stuffs, not corded.

DRUIDS, the priests or ministers of religion of the ancient Britons, and Gauls. The druids were chose out of the best families; and were held, both by the honours of their birth and their office, in the greatest veneration. They are said to have understood astrology, geometry, natural history, politics, and geography: they had the administration of all sacred things, were the interpreters of religion, and the judges of all affairs indifferently.

Whoever refused obedience to them, was declared impious and accursed; they held the immortality of the soul, and the metempsychosis; they are divided by some into several classes; they had a chief, or arch-druid in every nation: he was a sort of high-priest, having an absolute authority over the rest, and was succeeded by the most considerable among his survivors. The youth used to be instructed by them, retiring with them to caves and desolate forests, where they were sometimes kept twenty years. They preserved the memory and actions of great men by their verses; but are said to have sacrificed men to Mercury. Cæsar imagined that the druids came from Britain into Gaul, but several among the modern writers are of a different opinion.

DRUM, is a military musical instrument in form of a cylinder, hollow within, and covered at the two ends with vellum, which is stretched or slackened at pleasure by the means of small cords and sliding knots. It is beat upon with sticks. Some drums are made of brass, but they are commonly of wood. There are several beats of the drum, as assembly, chamade, reveillé, retreat, &c.

DRUM *of the ear*. See ANATOMY.

DRUMS, *kettle*, are two sorts of large basons of copper or brass, rounded in the bottom, and covered with vellum or goat-

skin, which is kept fast by a circle of iron, and several holes fastened to the body of the drum, and a like number of screws to screw up and down. They are much used among the horse, as also in operas, oratorios, concerts, &c.

DRUMMER, he that beats the drum, of whom each company of foot has one, and sometimes two. Every regiment has a drum-major, who has the command over the other drums. They are distinguished from the soldiers by clothes of a different fashion: their post when a battalion is drawn up, is on the flanks, and on a march it is betwixt the divisions.

DRUNKENNESS, *theory of.* The common and immediate effect of wine is to dispose to joy, *i. e.* to introduce such kinds and degrees of vibrations into the whole nervous system, or into the separate parts thereof, as are attended with a moderate continued pleasure. This it seems to do chiefly by impressing agreeable sensations upon the stomach and bowels, which are thence propagated into the brain, continue there, and also call up the several associated pleasures that have been formed from pleasant impressions made upon the alimentary duct, or even upon any of the external senses. But wine has also probably a considerable effect of the same kind, after it is absorbed by the veins and lacteals, *viz.* by the impressions which it makes on the solids, considered as productions of the nerves, while it circulates with the fluids in an unassimilated state, in the same manner, as may be observed of opium; which resembles wine in this respect also, that it produces one species of temporary madness. And we may suppose, that analogous observations hold with regard to all the medicinal and poisonous bodies, which are found to produce considerable disorders in the mind; their greatest and most immediate effect arises from the impressions made on the stomach, and the disorderly vibrations propagated thence into the brain; and yet it seems probable, that such particles as are absorbed, produce a similar effect in circulating with the blood.

Wine, after it is absorbed, must rarefy the blood, and consequently distend the veins and sinuses, so as to make them compress the medullary subtance, and the nerves themselves, both in their origin and progress; it must, therefore, dispose to some degree of a palsy of the sensations and motions; to which there will be a farther disposition from the great exhaustion of the nervous capillaments, and medullary substance, which a continued state of gaiety and mirth, with the various expressions of it, has occasioned. It is moreover to be noted, that the pleasant vibrations producing this gaiety, by rising higher and higher perpetually, as more wine is taken into the stomach and blood vessels, come at last to border upon, and even to pass into, the disagreeable vibrations belonging to the passions of anger, jealousy, envy, &c. more especially if any of the mental causes of these be presented at the same time.

Now it seems, that, from a comparison of these and such things with each other, the peculiar temporary madness of drunken persons might receive a general explanation. Particularly it seems natural to expect, that they should at first be much disposed to mirth and laughter, with a mixture of small inconsistencies and absurdities; that these last should increase from the vivid trains which force themselves upon the brain, in opposition to the present reality; that they should lose the command and stability of the voluntary motions from the prevalence of confused vibrations in the brain, so that those appropriated to voluntary motion, cannot descend regularly as usual; but that they should stagger and see double; that quarrels and contentions should arise after some time; and all end at last in a temporary apoplexy. And it is very observable, that the free use of fermented liquors disposes to passionateness, to distempers of the head, to melancholy, and to downright madness; all which things have also great connections with each other. The sickness and head-ach which drunkenness occasions the succeeding morning, seem to arise, the first from the immediate impressions made on the nerves of the stomach; the second from the peculiar sympathy which the parts of the head, external as well as internal, have with the brain, the part principally affected in drunkenness, by deriving their nerves immediately from it. See Hartley on Man.

DRUPA, in botany, a species of seed-vessel that is succulent, has no valve or external opening like the capsule and pod, and contains within its substance a stone or nut. The cherry, plumb, peach, apricot, and all stone fruit, are of this kind. The stone, or nut, which, in this species of fruit, is surrounded by the soft pulpy flesh, is a kind of woody cup, containing a single ker-

nel or seed. The definition just given, will apply to every seed-vessel denominated drupa in the "genera plantarum." The mond is a drupa, so is the seed-vessel of the elm-tree and the genus rumphia; though far from being pulpy or succulent, the first and third are of a substance like leather; the second like parchment. The same may be said of the walnut, pistacia-nut, and some others. Again, the seeds of the elm, flagellaria, and the mango-tree, are not contained in a stone. The seed-vessel of burr-reed is dry, shaped like a top, and contains two angular stones. This species of fruit, or more properly seed-vessel, is commonly roundish, and when seated below the calyx, or receptacle of the flower, is furnished, like the apple, at the end opposite to the foot-stalk, with a small umbilicus or cavity, produced by the swelling of the fruit before the falling off of the flower-cup.

DRY *rot*, a disease incident to timber used for building, such as flooring-boards, joists, wainscoting, &c. Dr. Darwin is of opinion, that the dry-rot may be entirely prevented, by soaking the timber first in lime-water, till it has absorbed as much of it as possible, and, after it has become dry, immersing it in a weak solution of vitriolic acid in water, which he supposes will not only preserve it from decay for many centuries (if it be kept dry), but also render it less inflammable; a circumstance that merits considerable attention in constructing houses. In the Transactions of the Society for the Encouragement of Arts, we meet with the following account of the cause of the dry rot in timber, and the method of preventing it, communicated by Mr. Batson, of Limehouse. He observes, that the dry rot having taken place in one of his parlours, to such a degree as to require the pulling down part of the wainscot every third year, and perceiving that it arose from a damp, stagnated air, and from the moisture of the earth, he determined, in the month of June, 1783, to build a narrow closet next the wall through which the moisture came to the parlour. This expedient had the desired effect. But, though the rot in the parlour was totally stopped, the evil soon appeared in the closet, where fungi of a yellow colour arose in various parts. In the autumn of the year 1786 the closet was locked up about ten weeks: on opening it, numerous excrescences were observed about the lower part; a white mould was spread by a plant resembling a vine, or sea-weed; and the whole of the inside, china, &c. was covered with a fine powder of the colour of brick-dust. On cleaning out the closet; it was discovered that the disease had affected the wood so far as to extend through every shelf, and the brackets that supported them. In the beginning of the year 1780, he determined to strip the whole closet of lining and floor, not to leave a particle of the wood behind, and also to dig, and take away, about two feet of the earth in depth, and leave the walls to dry, so as to destroy the roots or seeds of the evil. When, by time, the admission of air, and good brushing, it had become properly dry and cleansed, he filled it, of sufficient height for the joists, with anchor-smith's ashes, because no vegetable will grow in them. The joists being sawed off to their proper lengths, and fully prepared, they and their plates were well charred, and laid upon the ashes; particular directions being given, that no scantling or board might be cut or planed in the place, lest any dust or shavings might drop among the ashes. The flooring-boards being very dry, he caused them to be laid close, to prevent the dust getting down, which perhaps, in the course of time, might bring on vegetation. The framing of the closet was then fixed up, having all the lower pannels let in, to be fastened with buttons only, so that, if any vegetation should arise, the pannels might with ease be taken out and examined. In some situations it might be expedient and necessary to take out a greater depth of earth; and where ashes can be had from a foundry, they may be substituted for those of anchor-smiths; but house ashes are by no means to be depended upon. At the expiration of seven years from the period of making this experiment the wainscot was removed, and the flooring-boards also taken up, when they were found entirely free from any appearance of the rot: two pieces of wood (yellow fir) which had been driven into the wall as plugs, without being previously charred, were alone affected with this disease.

DRYANDRIA, in botany, so named in honour of Jonas Dryander, a Swede, and a most excellent botanist, a genus of the Dioecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx two-leaved; corolla five-petalled; or, calyx five-leaved, resembling a corolla, surrounded by a two or three leaved calycle; stamina nine; fruit three or four grained. There is but one species, *viz.* D. cordata.

DRYAS, in botany, a genus of the

Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx five to ten cleft; petals five to eight; seeds tailed, hairy. There are two species, *viz.* D. anemonoides, aud D. octopetala. The latter is a delicate evergreen plant, with snow-white blossoms. The stalks and branches are woody, and perennial, lying flat upon the ground, spreading wide about the roots in tufts. It is a native of high mountains in Lapland, Denmark, and Switzerland. Also in Scotland and in some parts of Yorkshire. It flowers in June.

DRYPIS, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-toothed; petals five; capsules clipped round, one seeded. There is only one species, *viz.* D. spinosa, the leaves of which are subulate, somewhat three cornered, mucronate; those at the subdivisions of the stem are lanceolate, with three teeth on each side; peduncles shorter than the flower; calyx erect; corolla crowned, as in Silene, purple or white; petals very narrow, spreading; stamens erect. It is biennial: native of Barbary, Italy, and Istria.

DUCATOON, a silver coin, frequent in several parts of Europe. See Coin—Table.

DUCES *tecum*, in law, a writ that commands a person to appear in the Court of Chancery, and bring with him certain writings, evidences, or other things, which the court is inclined to view.

DUCK. See Anas.

DUCKING *at the main-yard*, among seamen, is a way of punishing offenders on board a ship; and is performed by binding the malefactor, by a rope, to the end of the yard, from whence he is violently let down into the sea, once, twice, or three times, according to his offence: and if the offence be very great, he is drawn underneath the the keel of the ship, which they call keelhaleing.

DUCT, in general, denotes any tube or canal. See Anatomy.

DUCTILITY, in physics, a property of certain bodies, whereby they are capable of being expanded, or stretched forth, by means of a hammer, press, &c.

The great ductility of some bodies, especially gold, is very surprising: the gold-beaters and wire-drawers furnish us with abundant proofs of this property; they, every day, reduce gold into lamellæ inconceivably thin, yet without the least aperture, or pore discoverable, even by the microscope: a single grain of gold may be stretched under the hammer into a leaf that will cover many square inches, and yet the leaf remain so compact, as not to transmit the rays of light, nor even admit spirit of wine to transude. Dr. Halley took the following method to compute the ductility of gold: he learned from the wire-drawers that an ounce of gold is sufficient to gild, that is, to cover or coat a silver cylinder of forty-eight ounces weight, which cylinder may be drawn out into a wire so very fine that two yards thereof shall only weigh one grain; and consequently ninety-eight yards of the same wire only forty-nine grains: so that a single grain of gold here gilds ninety-eight yards; and, of course, the ten-thousandth part of a grain is here above one-third of an inch long. And since the third part of an inch is yet capable of being divided into ten lesser parts visible to the naked eye, it is evident that the hundred-thousandth part of a grain of gold may be seen without the assistance of a microscope. Proceeding in his calculus, he found, at length, that a cube of gold, whose side is the hundredth part of an inch, contains 2,433,000,000 visible parts; and yet, though the gold wherewith such wire is coated, be stretched to such a degree, so intimately does its parts cohere that there is not any appearance of the colour of the silver underneath.

Mr. Boyle, examining some leaf-gold, found that a grain and a quarter's weight took up an area of fifty square inches; supposing therefore the leaf divided by parallel lines $\frac{1}{100}$ of an inch apart, a grain of gold will be divided into five hundred thousand minute squares, all discernible by a good eye: and the same author shews, that an ounce of gold drawn out into wire, would reach 155 miles and a half.

But M. Reaumur has carried the ductility of gold to a still greater length: a gold wire every body knows is only a silver one gilt. This cylinder of silver, covered with leaf-gold, they draw through the hole of an iron, and the gilding still keeps pace with the wire, stretch it to what length they can. Now M. Reaumur shews that in the common way of drawing gold-wire, a cylinder of silver twenty-two inches long and fifteen lines in diameter is stretched to 1,163,520 feet, or is 634,692 lines longer than before, which amounts to about ninety-seven leagues. To wind this thread on silk for use they first flatten it, in doing which it

stretches at least $\frac{1}{7}$ farther, so that the twenty-two inches are now 111 leagues: but in the flattening, instead of $\frac{1}{7}$, they could stretch it $\frac{1}{4}$, which would bring it to 120 leagues. This appears a prodigious extension, and yet it is nothing to what this gentleman has proved gold to be capable of.

DUCTILITY *of glass.* We all know, that when well penetrated with the heat of the fire, the workmen can figure and manage glass like soft wax; but what is most remarkable, it may be drawn, or spun out, into threads exceedingly long and fine. Our ordinary spinners do not form their threads of silk, flax, or the like, with half the ease and expedition as the glass-spinners do threads of this brittle matter. We have some of them used in plumes for children's heads, and divers other works, much finer than any hair, and which bend and wave like hair with every wind. Nothing is more simple and easy than the method of making them. There are two workmen employed; the first holds one end of a piece of glass over the flame of a lamp, and when the heat has softened it, a second operator applies a glass hook to the metal thus in fusion; and, withdrawing the hook again, it brings with it a thread of glass, which still adheres to the mass: then, fitting his hook on the circumference of a wheel about two feet and a half in diameter, he turns the wheel as fast as he pleases; which, drawing out the thread, winds it on its run, till after a certain number of revolutions, it is covered with a skein of glass-thread. The mass in fusion over the lamp diminishes insensibly, being wound out like a clue of silk upon the wheel; and the parts, as they recede from the flame, cooling, become more coherent to those next to them, and this by degrees: the parts nearest the fire are always the least coherent, and, of consequence, must give way to the effort the rest make to draw them towards the wheel. The circumference of these threads is usually a flat oval, being three or four times as broad as thick: some of them seem scarcely bigger than the thread of a silk-worm, and are surprisingly flexible. If the two ends of such threads are knotted together, they may be drawn and bent, till the aperture, or space in the middle of the knot, does not exceed one-fourth of a line, or one forty-eighth of an inch in diameter. Hence M. Reaumur advances, that the flexibility of glass increases in proportion to the fineness of the threads; and that, probably, had we but the art of drawing threads as fine as a spider's web, we might weave stuffs and cloths of them for wear. Accordingly, he made some experiments this way; and found that he could make threads fine enough, *viz.* as fine, in his judgment, as spider's thread, but he could never make them long enough to do any thing with them.

DUEL, a single combat, at a time and place appointed, in consequence of a challenge. This custom came originally from the northern nations, among whom it was usual to decide all their controversies by arms. Both the accuser and accused gave pledges to the judges on their respective behalf; and the custom prevailed so far amongst the Germans, Danes, and Franks, that none were excused from it but women, sick people, cripples, and such as were under 21 years of age, or above 60. Even ecclesiastics, priests, and monks, were obliged to find champions to fight in their stead. The punishment of the vanquished was either death, by hanging or beheading; or mutilation of members, according to the circumstances of the case. Duels were at first admitted not only on criminal occasions, but on some civil ones for the maintenance of rights to estates, and the like: in latter times, however, before they were entirely abolished, they were restrained to these four cases: 1. That the crime should be capital. 2. That it should be certain the crime was perpetrated. 3. The accused must, by common fame, be supposed guilty. And, 4. The matter not capable of proof by witnesses. In England, though the trial of duel is disused, the law on which it is founded is still in force. See CHAMPION.

DUEL, at present is used for a single combat on some private quarrel, and must be premeditated, otherwise it is called a rencounter. If a person be killed in a duel both the principals and seconds are guilty of murder, whether the seconds engage or not. It is also a very high offence to challenge a person either by word or letter, or to be the messenger of a challenge.

DUET, in music, a composition expressly written for two voices or instruments, with or without a bass and accompaniments. In good duets the execution is pretty equally distributed between the two parts, and the melodies so connected, intermingled, and dependent on each other, as to lose every effect when separated, but to be perfectly related and concinnous when heard together.

DUKE is either the title of a sovereign prince, as the Duke of Savoy, Parma, &c. the Grand Duke of Tuscany, Muscovy, &c. or it is the title of honour and nobility next below princes. The commanders of armies in time of war, the governors of provinces, and wardens of marches, in time of peace, were called *duces*, under the latter emperors. The Goths and Vandals divided all Gaul into dutchies and counties, the governors of which they sometimes call *duces*, and sometimes *comites*. In France, under the second race of kings, though they retained the name and form of ducal government, there were scarce any dukes except those of Burgundy, Aquitain, and France. In England, among the Saxons, the commanders of armies, &c. were called dukes, *duces*, without any addition, till Edward III. made his son, the Black Prince, Duke of Cornwall; after whom there were more made in the same manner, the title descending to their posterity. Duke, then, at present, is a mere title of dignity, without giving any domain, territory, or jurisdiction, over the place from whence the title is taken. A duke is created by patent, cincture of sword, mantle of state, imposition of a cap and coronet of gold on his head, and a verge of gold put into his hand. His title is Grace; and, in the style of the heralds, Most high, potent, high-born, and noble prince.

DULCIMER, in music, is a triangular instrument, strung with about fifty wires cast over a bridge at each end, the shortest, or most acute of which is about eighteen inches long, and the longest or most grave thirty-six. It is performed upon by striking the wires by little iron rods.

DUMBNESS, the privation of the faculty of speech. The most general, or rather the sole cause of dumbness, is the want of the sense of hearing. The use of language is originally acquired by imitating articulate sounds. From this source of intelligence deaf people are entirely excluded; they cannot acquire articulate sounds by the ear: unless, therefore, articulation be communicated to them by some other medium these unhappy people must for ever be deprived of the use of language: and as language is the principal source of knowledge, whoever has the misfortune to want the sense of hearing must remain in a state little superior to that of the brute creation. Deafness has in all ages been considered as such a total obstruction to speech or written language, that an attempt to teach the deaf to speak or read has been uniformly regarded as impracticable, till Dr. Wallis, and some others, have of late shown, that although deaf people cannot learn to speak or read by the direction of the ear, there are other sources of imitation by which the same effect may be produced. The organs of hearing and of speech have little or no connexion. Persons deprived of the former generally possess the latter in such perfection that nothing further is necessary, in order to make them articulate, than to teach them how to use these organs. This, indeed, is no easy task; but experience shews that it is practicable. Mr. Thomas Braidwood, late of Edinburgh, was perhaps the first who ever brought this surprising art to any degree of perfection. He began with a single pupil in 1764, and since that period has taught great numbers of people born deaf to speak distinctly, to read, to write, to understand figures, the principles of religion and morality, &c.

But a new and different method, equally laborious and successful, we understand, is practised by the Abbé de l'Epee of Berlin. We are informed that he begins his instructions not by endeavouring to form the organs of speech to articulate sounds, but by communicating ideas to the mind by means of signs and characters: to effect this, he writes the names of things; and, by a regular system of signs, establishes a connexion between these words and the ideas to be excited by them. After he has thus furnished his pupils with ideas and a medium of communication, he teaches them to articulate and pronounce, and renders them not only grammarians but logicians. In this manner he has enabled one of his pupils to deliver a Latin oration in public, and another to defend a thesis against the objections of one of his fellow pupils in a scholastic disputation; in which the arguments of each were communicated to the other, but whether by signs or in writing is not said.

DUMOSA, (from Dumus, a bush) bushy plants; the name of the forty-third order in Linnæus's Fragments of a Natural Method; consisting of a number of shrubby plants, which are thick set with irregular branches, and bushy.

DUNG, in husbandry, is of several sorts, as that of horses, cows, sheep, hogs, pigeons, geese, hens, &c. See AGRICULTURE.

DUNGEON, in fortification, the highest part of a castle built after the ancient mode; serving as a watch-tower, or place

of observation; and also for the retreat of a garrison, in case of necessity, so that they may capitulate with greater advantage.

DUO, in music, a song or composition to be performed in two parts only, one sung, the other played on an instrument, or by two voices.

Duo is also when two voices sing different parts, as accompanied with a third, which is a thorough bass. It is seldom that unisons and octaves are used in duos, except at the beginning and end.

DUODENUM, the first of the small guts, so called from its length, which is about twelve fingers breadth. It has its origin at the pylorus, or right orifice of the stomach; from which ascending a little, it afterwards descends again, and towards its end re-ascends, and runs transversely towards the left kidney: at the distance of three or four fingers from the pylorus it receives, at one prominent hiatus or mouth, the choledochic and pancreatic ducts, which discharge their respective liquors into it. See Anatomy.

DUPLICATE, among lawyers, denotes a copy of any deed, writing, or account. It is also used for the second letters patent, granted by the Lord Chancellor in a case wherein he had before done the same. Also a second letter written and sent to the same party and purpose as the former, for fear of the first's miscarrying, is called a duplicate.

Duplicate *proportion*, or *ratio*, is a ratio compounded of two ratios: thus, the duplicate ratio of a to b, is the ratio of $a\ a$ to $b\ b$, or of the square of a to the square of b. Hence the duplicate ratio ought to be well distinguished from double.

In a series of geometrical proportionals, the first term to the third is said to be in a duplicate ratio of the first to the second: thus in 2, 4, 8, 16, &c. the ratio of 2 to 8 is duplicate of that of 2 to 4, or as the square of 2 to the square of 4. Duplicate ratio is therefore the proportion of squares, as triplicate is of cubes, &c. and the ratio of 2 to 8 is said to be compounded of that of 2 to 4, and of 4 to 8.

DUPLICATION, in general, signifies the doubling of any thing, or multiplying of it by 2: also the folding of any thing back again on itself. See Cube.

DURA *mater*, one of the membranes which surround the brain. See Anatomy.

DURANTA, in botany, so called in honour of Castor Durantes, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-cleft, superior; berry four-seeded; seeds two-celled. There are three species. These are shrubs with quadrangular branches; the flowers are in loose spikes, either from the axils, or at the ends of the branches. They have generally axillary spines; and they are so much alike in their manner of flowering, as well as in the structure and colour of the flower, that it is doubtful whether they may not be all one species.

DURATION, an idea which we get by attending to the fleeting and perpetually perishing part of succession; the idea of succession being acquired by reflecting on that train of ideas which constantly follow one another in our minds, as long as we are awake. The simple modes of duration are any different lengths of it whereof we have distinct ideas, as hours, days, years, time, eternity, &c. Duration, as marked by certain periods and measures, is what we most properly call time.

Duration *of action*, according to Aristotle, is confined to a natural day in tragedy; but the epopoeia, according to the same critic, has no fixed time.

Duration *of an eclipse*. See Astronomy and Eclipse.

Duration, in botany, the division of vegetables into trees, and perennial and annual herbs, is founded on the different duration of these plants. Trees subsist for several years, both by the root and stem: perennial herbs lose their stems during the winter, and are renewed by the root in the following spring: annuals perform the changes of vegetation but once, and are perpetuated in the seed. Striking as those differences are, Linnæus thinks the duration of plants so fallacious, that he never employs it as a specific difference. The reason he assigns is very pertinent. The duration of plants, he says, is frequently affected by place or climate, and therefore ought not to be regarded as an invariable circumstance proper for discriminating the species. In the warmer climates, which enjoy a perpetual summer, most of the plants are perennial, and of the tree-kind; yet many of them, when removed to our colder European climates, lose their woody texture, and become herbaceous and frequently annual. Of this the ricinus, or tree palma christi, and marvel of Peru, are familiar instances.

Indian cress, beet, sweet marjoram, and tree-mallow, which, with us, are annual,

become, in very warm regions, perennial and shrubby.

DURESSE, in law, is where a person is wrongfully imprisoned, or restrained of his liberty, contrary to law; or is threatened to be killed, wounded, or beaten, till he executes a bond, or other writing. Any bond, deed, or other obligation, obtained by duresse, will be void in law; and in an action brought on the execution of any such deed, the party may plead that it was brought by duresse. A deed must be avoided by special pleading, in these cases; for the party cannot plead to it, *non est factum*, because it is his deed.

DURIO, in botany, a genus of the Polyadelphia Polyandria class and order. Natural order of Putamineæ. Capparides, Jussieu. Essential character: calyx five-cleft, pitcher shaped, inferior; corolla five-petaled, small; style one; stamina in five bodies; pome five-celled. There is only one species, *viz.* D. Zibethinus, a lofty tree with flowers below the leaves, which are alternate. The leaves resemble those of the cherry, but not dented at the edges, the flowers are borne in loose heads; they are large, and of a pale yellow white. The fruit is very large, the fleshy part of which, is of a creamy substance and delicate taste, but of an unpleasant smell. Native of the East Indies.

DUROIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: calyx cylindric, truncate; corolla six parted; filaments none; pome hispid. There is but one species, *viz.* D. eriopila, a tree, with thick unequal branches, hirsute at the end; leaves terminating, opposite, approximating; petioles very short; flowers at the ends of the branches, sessile, many, several of them abortive; corollas white, fruit larger than a turkey's egg, spherical, covered very thick with erect brown hairs; umbilicate, with the hollow calyx; it is well flavoured, and much esteemed at Surinam, where it is a native.

DUTCHY *court*, a court of the dutchy-chamber of Lancaster, held at Westminster, before the chancellor of the same, for matters concerning the lands and franchises of that dutchy. The proceedings in this court are by English bill, as in chancery. Gwyn says, that this court grew out of the grant of king Edw. III. who gave the dutchy to John of Gaunt, and endowed it with royal rights and privileges; several others of our ancient kings likewise separated this dutchy from the crown, and settled it in the natural persons of themselves and their heirs; though, in succeeding times, it was united to the crown again.

DUTY, in general, denotes any thing that one is obliged to perform.

Duty, in polity and commerce, signifies the impost laid on merchandizes, at importation or exportation, commonly called the duties of customs; also the taxes of excise, stamp duties, &c. See Customs, Excise, &c.

DWARF, in general, an appellation given to things greatly inferior in size to that which is usual in their several kinds; thus there are dwarfs of the human species, dwarf-dogs, dwarf-trees, &c.

Dwarf *fruit-trees* are propagated by grafting them on a quince-stock, about six inches above the ground; and when the bud is shot so far as to have four eyes, it must be stopped, to give rise for lateral branches, for which purpose the uppermost eye should always be left outwards. Apple, pear, plum, and cherry-trees are thus formed into dwarfs, but the summer and autumn pears are found to succeed best. As to the planting of dwarf-trees, they should be set at twenty-five feet square distance, and the ground between sown or planted for kitchen use while the trees are young, only keeping at some distance from their roots; stakes also should be fixed all round them, to which the branches may be nailed with list, and thereby trimmed in an horizontal direction, and prevented from crossing one another.

DYE, any square body, as the trunk, or notched part of a pedestal; or it is the middle of the pedestal, or that part included between the base and the corniche, so called because it is often made in the form of a cube or dye. See Architecture.

DYEING, as the word is commonly used, is the art of communicating colour of some considerable degree of permanence to articles used in clothing; the processes for colouring other substances will be found under the articles of staining wood, bone, leather, and marble.

This art is probably of great antiquity, as we find accounts of coloured garments in the earliest records of history. The ancient Egyptians must have carried it to great perfection, as the method of producing very brilliant colours of extreme durability was well known to them, numerous specimens of such colours on various

substances being still found on the walls of their early built temples, on the sides of their catacombs, and on the coverings of their mummies; and it may be fairly inferred, from their producing such fine colours on these substances, that they must have known how to do so on other substances, and in other manners; besides which, Pliny expressly mentions, (Hist. Nat. Lib. 35. chap. 2.) that the Egyptians had a mode of dyeing, which from his description, was very like that which we use for colouring printed linens, as the stuffs were immersed in vats, where they received various colours, probably after having been impregnated with different mordants.

Among the Greeks, dyeing was but little practised; but the Tyrians, who may be called their neighbours, were, at a very early period, acquainted with the method of producing the beautiful tint of purple, for which they were so long famous; from the Tyrians the art proceeded to the Greeks, and from them to the Romans.

The ancients also obtained from the coccus, now known by the name of kermes, a colour which was almost as highly esteemed as the purple, and which was sometimes mixed with it. See Coccus.

There is reason to think it was not till the time of Alexander, that the Greeks attempted materially to improve the black, blue, yellow, and green dyes; which it is probable they learned the means of effecting from the natives of Asia, with which the conquests of Alexander rendered them familiar, and among some of whom, particularly the Indians, the art of dyeing fine colours was known from the earliest antiquity. But as the art of dyeing has not proceeded to us directly from the Indians, it is sufficient to note this circumstance, in tracing its progress in countries more adjacent to our own.

The qualities of the colours used by the ancients, may be judged of by the substances employed in making them; of which M. Biscoff, who has minutely examined the subject, enumerates the following ingredients, in addition to the coccus and purple shell fish:

1. Alum; but this it is probable the ancients were unacquainted with in its present state of purity.

2. Alkanet, which Suidas says was used by women as a paint.

3. The blood of birds, which was used among the Jews.

4. The fucus; that of Crete was preferred, and was generally employed as a ground for valuable colours.

5. Broom.

6. The violet; from which the Gauls prepared a colour that resembled one kind of purple.

7. Lotos medicago arborea, snail trefoil; the bark was used in dyeing skins, and the root in dyeing wool.

8. The bark of the walnut tree, and the peel of the shell.

9. Madder; there is no certainty whether the ancients used the same species with us, or another root of the same tribe.

10. Woad; but we do not know that the ancients used the same preparation of it which we do.

Our acquisitions of dyeing materials, especially since the discovery of America, give us such a decided superiority over the ancients in this respect, that we probably have no cause to regret the loss of their methods, even in the instance of their celebrated purple, which it may be questioned if we do not equal in beauty with a purple prepared from other much cheaper materials.

The kermes affords a colour which was almost as highly esteemed by the ancients as the purple, and we probably know how to employ the kermes to greater advantage than they did, as we possess alum in a state of purity, which they knew not how to obtain, with which the stuff is prepared to receive a more durable and beautiful colour; yet our dyers have almost entirely discontinued the use of it, because they can obtain from cochineal a colour beyond all comparison more beautiful.

The ancients were also unacquainted with that useful substance, soap, which gives us a superiority in scouring, and some parts of the art of dyeing; instead of it they used two species of plants, one called radicula by Pliny, and struthian by the Greeks, which some think to be our saponaria, soap-wort; and the other being a species of poppy, according to Pliny: some of the bolar earths were likewise employed for the same purpose.

From America we have acquired several substances, which have been found useful in dyeing; namely, cochineal, brasil-wood, and anotta. But above all we are indebted for the superiority of our colours, to our preparations of alum, and the solution of tin, which give so much brilliancy to many of our dyes.

The Venetians, who derived much

their power from furnishing shipping for the Crusades, acquired the arts of dyeing used in the east at the same time: from thence they spread over the rest of Italy; in the year 1338, Florence contained two hundred thousand manufacturers, who are said to have made from seventy to eighty thousand pieces of cloth.

About the year 1300, archil is said to have been discovered accidentally by a Florentine merchant. Having observed that urine gave a very fine colour to a certain species of moss, he made experiments, and learned to prepare archil. He kept this discovery long secret, and his posterity, (a branch of which still subsists, according to Dominique Manni,) have retained the name *Ruccellai*, from oreiglia, the Spanish term for that species of moss.

The first collection of the processes employed in dyeing, appeared in Venice, in the year 1429, under the title of "Mariegola del' Arte de i Tentori:" a second edition of it much improved came out in 1510; and a certain person called Ventura Rosetti, having formed the design of rendering this description more useful and extensive, travelled through the different parts of Italy, and the neighbouring countries, to make himself acquainted with the various processes employed, which he published under the title "Plictho", and which, according to M. Bischoff, ought to be considered as forming the leading step toward the perfection which the art of dyeing has since attained. It is remarkable that in "Plictho," not a word is said either of cochineal or of indigo, which makes it probable that these two dyes were not employed in Italy.

Pliny speaks of a substance called indicum, but only as being used in painting. It is probable, however, that the Indians employed it in dyeing. The first of it used in Europe appears to have been brought by the Dutch from the East Indies. The cultivation of it in America, was first established in Mexico, and afterwards in other parts, where it acquired a superior quality to that which is procured from India. The use of indigo was not at first easily established; it was strictly prohibited in England in the reign of Elizabeth, as was also logwood, and the prohibition was not taken off till the reign of Charles II. Its use was also proscribed in Saxony, and in the edicts against it, it is spoken of as a corrosive colour, and called food for the devil, *fressende teufels*.

The prohibitions against indigo, were caused by the representations of those who prepared woad, that its use would destroy the sale of this article, which was the produce of the country. The prejudice against indigo was likewise communicated to France, and Colberts' instruction forbad the use of more than a certain quantity in the pastel vats.

Cochineal was introduced into Europe shortly after the conquest of Mexico. The Spaniards having observed that the Mexicans employed cochineal in painting their houses, and in dyeing their cotton, gave their government an account of it; and in the year 1523, Cortes was ordered to promote the increase of the valuable insect from which it is obtained.

The natural colour obtained from cochineal, is only a dull crimson; but soon after it was known in Europe, an eminent chemist, of the name of Kepfler, found out the present process for dyeing scarlet with it, by means of a solution of tin, and carried the secret to London in the year 1543: this process was first used at Bow, and hence the scarlet produced by it was called the Bow dye.

A Flemish painter, called Gluck, got possession of the secret, and communicated it to Giles Gobelin, who established a manufactory of it in the place in France, which still bears his name. This undertaking was deemed so rash, that it was termed Gobelin's folly: but his astonishing success at length induced people to suppose that he had made a compact with the devil, from which the application of the term goblins to evil spirits is probably derived. The knowledge of this process afterwards spread throughout all Europe.

The discovery of this mode of dyeing scarlet may be considered as the most remarkable æra in the art of dyeing. The ancients applied the name scarlet to a colour obtained from kermes, which was much inferior in beauty to the colour procured from cochineal.

Dufay, Hellot, Macquer, and Berthollet, were successively charged by the French government with the care of improving the art of dyeing. Dufay was the first who entertained just, though imperfect, ideas of the nature of colouring substances, and the power by which they adhere; he examined certain processes with great sagacity, and established the surest methods that could at that time be employed, for determining the goodness of a

colour. Hellot published a methodical description of the processes used in dyeing wool, which even now is the best treatise we have on the subject. Macquer has given an exact description of the processes employed in dyeing silk; he has made us acquainted with the combinations of the colouring principle of Prussian blue; he has endeavoured to make an application of it to the art of dyeing, and has given us a process for communicating the most brilliant colours to silk by means of cochineal. He intended to publish a general treatise on the art of dyeing, of which he gave the prospectus in 1782; but his death, which took place in 1784, prevented the execution of any part of the work.

Berthollet succeeded Macquer; his treatise on dyeing is one of the best epitomes on the subject; and chemistry, and the arts of dyeing, and of bleaching, have been much indebted to his labours.

In his theory of dyeing, he refers all the combinations produced in the formation of colours to the laws of chemical attraction; and all the changes, which the colouring particles undergo, to the conjunction of the elements of the new combination. The first effect of the attraction, he considers as analogous to the formation of neutral salts; the second to combustion, putrefaction, and many other operations of nature.

Besides the authors mentioned, Chaptal, D'Apligny, D'Ambourney, and Hauffman, in France, have published treatises on the art of dyeing, which have much contributed to its improvement. In Sweden, Scheffer alone has written on the subject; his work is accompanied with notes by the celebrated Bergman. In Germany experiments in different processes of dyeing have been published by Beckmann, Poerner, Vogler, and Francheville. In England two very valuable essays on dyeing, by Delaval and by Henry, have appeared; to which may be added, the excellent treatise on the philosophy of permanent colours, by Dr. Bancroft.

Of the Attractions of colouring Substances.

A variety of theories have been produced by ingenious men to account for the effects of dyeing. Bergman seems to be the first who referred them entirely to chemical principles; and this opinion is so consonant to reason, that it is now universally adopted.

Dyeing then is to be considered merely as a chemical process: but in order that it may succeed, it is necessary that the colouring matters should be dissolved in some fluid, (for in their solid state no attraction takes place between them and the stuff,) and that their attraction to the fluid should be less than that to the stuff. Besides the colouring matters being brought within the proper distance for attraction by this means, they are also caused to apply themselves more equally, as every part of the stuff has thus an opportunity of attracting to itself the proper quantity of colouring matter.

The stuff receives the dye better in proportion to the degree of affinity which the colouring matter has to it and to the solvent relatively, for if its attraction to the stuff is much more than to the solvent, the stuff receives the dye too rapidly, and it will be scarcely possible to prevent its being unequal: but if, on the other hand, its attraction to the solvent is too great, the stuff will either not take the dye at all, or it will take it very slowly and faintly. Wool has a stronger attraction for colouring matters than silk, silk than cotton, and this latter a stronger than linen. Hence it is necessary to use solvents for the dyes of the stuffs last mentioned, which have a weaker affinity for them than for those used in dyeing wool.

The essential circumstances in dyeing are to ascertain the affinities of the colouring substance; first, to the solvents; secondly, to those substances which modify its colour, increase its brilliancy, and strengthen its union with the stuff; thirdly, to the different agents, which may change the colour, and principally to air and light.

The colouring matters possess chemical properties, that distinguish them from all others; they have attractions peculiar to themselves, by means of which they unite with acids, alkalies, metallic oxides, and some earths, particularly alumen. They frequently precipitate oxides and alumine from the acids, which held them in solution; at other times they unite with salts, and form supra-compounds, which combine with the wool, silk, cotton, or linen: and with these their union is rendered much more close by means of alumine, or a metallic oxide, than it would be without their intervention.

The qualities of the uncombined colouring particles are modified when they unite with any substance; and if this compound

unites with a stuff, it undergoes new modifications. Thus, the properties of the colouring particles of cochineal are modified, by being combined with the oxide of tin; and those of the substance thence resulting are again modified by their union with the wool or silk; and all these modifications are analogous to what is observed in other chemical combinations.

Of Mordants.

The title of mordant is applied to those substances which serve as intermedes between the colouring particles and the stuff to be dyed, either for the purpose of facilitating, or of modifying their combination; and by their means colours are varied, brightened, made to strike, and rendered more durable.

Was it possible to procure a sufficient number of colouring matters having a strong affinity to cloth, to answer all the purposes of dyeing, that art would be exceedingly simple and easy. But except indigo, there is scarcely a dye-stuff which yields of itself a good colour, sufficiently permanent to deserve the name of a dye. This difficulty is obviated by employing an intermediate substance, which has a strong affinity both for the stuff and the colouring matter, and this is the principal purpose for which the mordant is used.

A mordant is not always a simple agent; new combinations are sometimes formed by the ingredients which compose it; so that the compounds resulting from the mixture, and not the simple substances that compose it, are the immediate agents, which produce the effect.

Sometimes the mordant is mixed with the colouring particles, sometimes the stuff is impregnated with it, and on other occasions both those modes are united; and finally stuffs are dyed successively with liquors containing different substances, the last of which only can act on that with which the stuff is impregnated.

The principal substances employed as mordants are aluminous salts, lime, metallic oxides, some astringent substances, and animal matters.

Formerly sulphate of alumen was the only species used as a mordant in dyeing; but of late years acetite of alumen has been introduced with excellent effect, particularly for cottons or linens, whose attraction to the alumen being weak, they require it to be applied, combined with a substance to which it has not so strong an union as it has to sulphuric acid; and its attraction to acetous acid is found to be sufficiently inferior to that for the cotton or linen, that it readily quits the acetous acid to combine with them.

Acetite of alumen is prepared by pouring acetite of lead into a solution of alum, in the proportion of one part of the acetite of lead to three of the alum in weight, a sixteenth of potash, and as much of powdered chalk are also added. In this mixture the sulphuric acid combines with the lead, and is precipitated; and the alumen or base of the alum, combines with the acetous acid as it parts from the lead, and forms acetite of alumen; the chalk and potash serve to saturate the excess of acid.

The final effect of alumining, in whatever way performed, and whatever chemical changes may have taken place in it, consists in the combination of alumen with the stuff; this union is probably imperfect, and the acids but partially separated at first, but becomes complete when the stuff is afterwards impregnated with the colouring substance.

The attraction of alumen for animal substances may be shewn by direct experiment; for if a solution of alum is mixed with a solution of glue, on adding an alkali, the glue is precipitated in combination with the alumen.

The attraction of alumen for most colouring substances may also be proved by experiment. If a solution of a colouring substance be mixed with a solution of alum, and an alkali be added, which decomposes the alum, the colouring matter will be precipitated combined with the alum, and the liquor will remain clear. The matter precipitated is called a lake. In this experiment too much alkali must not be added, because alkalis are capable of dissolving most lakes.

No direct experiment has yet shewn that alumen attracts any vegetable substances, except colouring matters: its attraction to them seems much weaker than that which it has for animal substances; hence the acetite of alumen is a better mordant than alum, for linen and cotton, as has been observed; and upon this depend the different means employed to increase the fixidity of the colouring particles in dyeing these substances.

Lime is the only earth besides alum which is employed in dyeing: the affinity of lime for cloth is sufficiently strong; it is however

found to answer the purpose of a mordant less perfectly than alumen, on account of the colour, which is not so good. It is employed either in the state of lime-water, or of that of sulphate of lime dissolved in water.

Metallic oxides have so great an attraction for many colouring substances, that they quit the acids in which they were dissolved, and are precipitated in combination with them: they have also the property of uniting with animal substances; it is therefore natural that they should serve as a bond of union between the colouring particles and animal substances; but besides the attraction of the oxides for colouring substances, and for animal matter, their solutions in acids possess qualities which render them more or less fit to act as mordants: thus those oxides which easily part with their acids, such as that of tin, are capable of combining with animal substances without the aid of colouring particles: it is sufficient to impregnate wool or silk with a solution of tin, although they be afterwards carefully washed, which is not the case with other metallic solutions.

Some metallic substances afford in combination only a white and colourless basis; and some by the admixture of their own colour modify that which is proper to the colouring particles; but in many metallic oxides, the colour varies according to the proportion of the oxygen they contain, and the quantity of this is easily liable to change. Upon these circumstances their properties in dyeing principally depend.

The attraction of metallic oxides for substances of vegetable origin is much weaker than for animal substances, and we are even ignorant whether they are capable of contracting a real union with them or not; metallic solutions are therefore ill fitted to serve as mordants for colours in linen or cotton, except iron, the oxide of which unites firmly with vegetable substances, as is shewn by iron moulds, which are owing to a real combination of this oxide. When the colouring particles have precipitated a metallic oxide from its menstruum, the supernatent liquor contains the disengaged acid, which is commonly capable of dissolving a portion of the compound of colouring substance and oxide, so that the liquor remains, coloured; but sometimes the whole of the colouring matter is precipitated, when the proportions have been accurately adjusted: this precipitation is facilitated, and rendered more complete by the presence of the stuff, which assists by the tendency it has to unite with the compound of oxide and colouring matter.

Uncombined metallic oxides have also a very evident action on many colouring substances, when boiled with them, and modify their colour; the oxide of tin in particular increases the brightness and fixidity of several.

The compounds of oxides and colouring substances may be compared to many other chemical compounds, which are insoluble when the principles of which they are formed are properly proportioned, but which are capable of being super-saturated by an excess of one of the principles, and thence of becoming soluble. Thus a metallic oxide united with a colouring substance in excess, will produce a liquor, the colour of which will be modified by the oxide; whereas, when the colouring matter is not in excess, the compound will be insoluble or nearly so: these effects are very evident in the combination of iron with the astringent principle.

Some other saline substances, as well as the metallic salts, are also employed as mordants. The neutral salts, sal ammoniac, nitre, and particularly sea-salt, act as mordants and modify colours, but it is difficult to ascertain the manner in which they act: salts with calcareous bases also modify colours; but as these modifications are nearly similar to those which would be produced by the addition of a small quantity of lime, it is probable they are decomposed, and that a little of the lime enters into combination with the colouring particles and the stuff.

Astringent substances are often employed as mordants. Tan, or the astringent principle, having a strong affinity for cloth, and for colouring substances, is found very useful for this purpose. It is commonly prepared by infusing nut-galls in water; the cloth is immersed in this solution, and allowed to remain till it is sufficiently impregnated with the tan. Sumach, which consists of the shoots of the rhus coriaria (a shrub that grows in the southern parts of Europe), is often used and prepared in the same way as nut-galls.

Animal substances are sometimes used as mordants; in the process for dyeing the Turkey red, the cotton stuff is impregnated with animal oil; and it is probable linen and cotton would take other colours better after some similar preparation.

Exsiccation favours the union of the sub-

stances which have an attraction for the stuff, and the decompositions which may result from that union; but the exsiccation should be slow, that the substances may not be separated before their mutual attractions have produced their effect.

To judge of the most advantageous manner of employing mordants, we must first pay attention to the combinations which may be produced, either by the action of the substances which compose them, or by that of the colouring matter and the stuff; secondly, to the circumstances which may concur in bringing about these combinations more or less quickly, or in rendering them more or less complete; thirdly, to the action that the liquor in which the stuff is immersed may have, either on its colour or texture; and in order to foresee what that may be, it is necessary to know the proportions of the principles which enter into the composition of the mordant, and what will be left in an uncombined state in the liquor.

Of the action of air and light on colours.

The action of atmospheric air on colours is chiefly owing to the oxygen it contains; this Berthollet has shewn in some cases to have similar effects to a slight combustion; as when the air renders a substance yellow, fawn-coloured, or brown, which he supposes it does by the oxygen combining with the hydrogen of the stuff, and leaving the charcoal predominant, which then communicates its own colour to it. The action of the air in bleaching he supposes to be caused by the combination of its oxygen with the colouring matter of the stuff, which renders it soluble in alkaline lixivia; which for this reason should always be used alternately, with exposure to the air.

The changes which occur in the colours produced by the union of colouring matter with metallic oxides, are effects compounded of the change that takes place in the colouring matter, and of that which the metallic oxide undergoes.

The light of the sun considerably accelerates the alteration of colours; this, according to Berthollet, it effects by favouring the combination of oxygen, and by the combustion thereby produced. Mr. Sennebier (who has published many interesting observations on the effect of light on colours), on the contrary, attributes these effects to a direct combination of light with the substances; but Berthollet established his opinion by a number of accurate experiments, which give it a decided superiority.

Colouring substances resist the action of the air more or less, according as they are more or less disposed to unite with oxygen, and thereby to suffer more or less quickly a smaller or greater degree of combustion: light favours this effect; but the colouring matter, in its separate state, is much more prone to this combustion than when united to a substance, such as alumen, which may either defend it by its own power of resisting combustion, or, by attracting it strongly, weaken its action on other substances, which is the chief effect of mordants; and this compound acquires greater durability when it is capable of combining intimately with the stuff. Thus the colouring matter of cochineal dissolves easily in water, and its colour is quickly changed by the air; but when united to the oxide of tin, it becomes much brighter and almost insoluble in water, though it is still easily affected by the air, and by oxygenated marine acid: it resists the action of these better however when it has formed a triple compound with a woollen stuff.

Oxygen may unite in a small proportion with some colouring substances, without weakening their colour, or changing it to another: thus indigo, which becomes green by uniting with an alkali, with lime, or a metallic oxide, resumes its colour, and quits those substances, when it recovers a small portion of the oxygen which it had lost. The liquor of the whelk, employed to dye purple, is naturally yellowish; but when exposed to the air, and more especially in the sunshine, it quickly passes through various shades, and at length assumes that colour so precious in the eyes of the ancients.

It may be considered as a general fact that colours become brighter by their union with a small portion of oxygen; for this reason it is found necessary to air stuffs, when they come out of the bath, and sometimes even to take them out of it from time to time, expressly for this purpose; but in some cases the quantity of oxygen, which thus becoming fixed, contributes to the brightness of the colour is very inconsiderable, and its deterioration soon commences.

The action of the air affects not only the colouring matter and the stuffs, but also metallic oxide, when they are employed as intermedes, because the oxides are deprived at first by the colouring matter of part of their oxygen, and absorb it afterwards from the air. Those oxides then, whose colour

varies in proportion to their quantity of oxygen, cause changes of colour in the stuff in this manner.

Thus the blue given to wool, by sulphate of copper and logwood, soon changes into a green by the action of the air; because the copper, which is blue, when combined with a small portion of oxygen, becomes green, by its union with a larger quantity.

Colouring matter, in a state of combination with most substances, is less liable to be changed by the air, than when uncombined; but there are some exceptions; for alkalies produce a contrary effect: they darken the colours to which they are added, and are found by experiment to promote the absorption of air, and in proportion as this takes place, the colours in general become more and more brown. This is consonant to the effect they produce on other substances, such as sulphur, for they favour the absorption of air, because they have a strong attraction for the substance which is the result of that absorption.

Of the differences between Wool, Silk, Cotton, and Linen, and the operations by which they are prepared for Dyeing.

Wool and silk are animal substances, cotton and linen are vegetable productions. Animal substances have a greater disposition to combine with other substances, than those of vegetable origin; hence they are more liable to be destroyed by different agents, and are more disposed to combine with colouring particles. Berthollet accounts for these properties by their principles being more disposed to assume a gaseous form, and having less cohesive force among themselves. Thus the pure, or caustic alkalies destroy animal substances, because they combine with them, and thereby lose their causticity. For this cause animal substances cannot bear leys, and alkalies should be used with great caution in the processes for dyeing them; whereas no danger is to be apprehended from the use of alkalies with vegetable substances. Nitric and sulphuric acids have also considerable action on animal substances.

Silk appears to bear some resemblance to vegetable substances, by being less disposed to combine with colouring particles, and by resisting the action of alkalies and acids more powerfully; but though the action of these substances on silk is weaker than upon wool, they should still be employed with great caution, because the brightness of colour in silk appears to depend upon the smoothness of its surface, which should therefore be preserved unimpaired.

Cotton withstands the action of acids better than flax or hemp, and is difficultly destroyed even by the nitric acid.

Of Wool.

Wool is naturally covered with a kind of grease called suint, which preserves it from moths, so that it is not scoured until it is about to be dyed or spun. In order to scour wool it is put for about a quarter of an hour into a kettle containing a sufficient quantity of water, mixed with a fourth part of putrid urine, heated to such a degree as the hand can just bear, and it is stirred from time to time with sticks; it is then taken out and put to drain. It is next carried in a large basket to a stream of running water, where it is moved about until the grease is entirely separated, and no longer renders the water turbid; it is then taken out, and again left to drain. It sometimes loses in this operation more than a fifth of its weight. The scouring should be carefully performed, because the wool is thereby better fitted to receive the dye. In this process the volatile alkali of the urine unites with the grease, and forms a kind of soap soluble in water.

When wool is dyed in the fleece, its filaments being separate absorb a larger quantity of the colouring matter; for the same reason woollen yarn takes up more than cloth, but cloths themselves vary considerably in this respect, according to their degree of fineness, or the closeness of their texture. The wool dyed in the fleece is chiefly intended to form cloths of mixed colours.

For most colours wool requires to be prepared by being boiled with saline substances, principally with alum and tartar. For some dyes wool does not require this preparation, and then it must be well washed in warm water, and wrung out, or left to drain.

The asperity of the surface of the filaments of wool, and their disposition to acquire a progressive motion towards their roots, forms an obstacle to the spinning of wool, which is removed by impregnating it with oil. This oil must be discharged previous to the stuff, formed of the wool, being dyed. For this purpose it is carried to the fulling mill, where it is beaten with large beetles in a trough of water, in which

a particular kind of clay has been diffused, that uniting with the oil, renders it soluble in the water.

Of Silk.

Silk is naturally coated with a substance, which has been considered as a gum, to which it owes its stiffness and elasticity; that which is most commonly met with, contains besides a yellow colouring matter. Most of the purposes for which silk is employed require that both these substances should be removed, which is effected by scouring it with soap.

The scouring ought not to be so complete for silks which are to be dyed, as for those which are intended to remain white, and a difference ought to be made according to the colour the silk should leave.

This difference consists in the quantity of soap employed; for common colours the silk is boiled for three or four hours in a solution of twenty pounds of soap for every hundred of silk, taking care to fill up the kettle from time to time, that there may be always a sufficient proportion of fluid. The quantity of soap is increased for those silks which are to be dyed blue, and more especially for those which are to be scarlet, cherry colour, &c. because for these colours the ground must be whiter than for such as are less delicate.

When silk is intended to be employed white, it undergoes three operations: First, the hanks of silk are kept in a solution of thirty pounds of soap to the hundred weight of silk, which ought to be very hot, but not boiling. When the immersed part of the hanks is freed from the gum, they are turned upon the skein sticks, that the parts not before immersed may undergo the same operation; they are then taken out of the kettle, and wrung out according as the operation is completed.

In the second operation, the silk is put into bags of coarse cloth, five and twenty, or thirty pounds in each bag, which is called a boiling bag. In these bags it is boiled for an hour and a half in a bath of soap, prepared like the former, but with less soap, taking care to keep the bags constantly stirred, that those which touch the bottom of the kettle may not receive too much heat.

The third operation is intended principally to give the silk a slight cast, to make the white more pleasing; from which it derives different names, such as China white, silver white, azure white, or thread white. For this purpose a solution of soap is prepared, the proper strength of which is determined by its mode of frothing when agitated; for the China white, which should have a slight tinge of red, a small quantity of anotta is added, and the silk is shaken over in it till it has acquired the desired shade. To the other whites more or less of a blue tinge is given, by adding a little blue to the solution of soap.

The preparation of silk with alum is necessary in all cases, for without it the greatest part of the colours applied, would possess neither beauty nor durability. For this operation forty or fifty pounds of Roman alum, previously dissolved in warm water, is mixed with about forty or fifty pails of water.

After having washed and beetled the silk, and wrung it out with the jack and pin, in order to separate any soap it may have retained, it is immersed in the alum liquor for eight or nine hours, after which it is wrung out by hand over the vat, and washed in a stream of water.

The above quantity of liquor will be sufficient for one hundred and fifty pounds of silk; but when it grows weak, which is known by the taste, twenty or twenty-five pounds of alum, dissolved as before, must be added, and this addition must be repeated, till the liquor acquires a disagreeable smell, and then it may be employed for stuffs intended for browns, marones, and other dark colours, till it has lost all its strength. The preparation of silk with alum is always made in the cold, because if the liquor should be employed hot, the lustre of the silk is liable to be impaired.

Of Cotton.

The several species of cotton differ principally in the length of their filaments, their fineness, their strength, and colour. They are of different shades, from a deep yellow to a white. The darkest cotton comes from Siam and Bengal, and is often made into stuffs in its natural colour. The most beautiful is not always the whitest; it is necessary to bleach it. Processes similar to those employed for linen, may be employed; but those in which oxygenated muriatic acid has been used, are more expeditious, produce a more beautiful white, and prepare the cotton better (according to M. Décroisille) for the reception of a fine colour in dyeing.

In order to dispose cotton to receive the dye, it must be first scoured; some boil it in sour water, but more frequently alkaline ley is used; the cotton must be boiled in it for two hours, and then rung out, afterwards be rinsed in a stream of water till the water comes off clear, and then be dried. The cotton stuffs, which are to be prepared, must be soaked for some time in water, mixed with at most one-fiftieth of sulphuric acid, after which they must be carefully washed in a stream of water and dried. The acid employed in this operation has been observed to take up a quantity of calcareous earth and iron, which would have injured the colours.

Aluming and galling are generally necessary in dyeing cotton and linen.

In the preparation with alum, about four ounces of it are required to each pound of the stuff. It must be employed with the precautions mentioned in the last article; some add a solution of soda in the proportion of one sixteenth of the alum, others a small quantity of tartar and arsenic. The thread is well impregnated by working it pound by pound in this solution. It is then put altogether into a vessel, and what remains of the liquor is poured upon it. It is left there for twenty-four hours, and then removed to a stream of water, where it is suffered to remain for an hour and a half, or two hours, in order to extract a part of the alum, and it is then washed. In this operation the cotton gains about one fortieth of its weight.

In the operation of galling, different quantities of galls, or other astringents, are used, according to the quality of the astringents, or the effect desired. The galls powdered, are boiled for about two hours in a quantity of water proportioned to that of the thread to be galled; the liquor is then suffered to cool to a temperature, which the hand can just support, after which it is divided into a number of equal parts, that the thread may be wrought pound by pound, and what remains is poured upon the whole together, as described in the process of aluming. It is then left for twenty-four hours, especially when intended for maddering for black, but for other colours twelve or fifteen are sufficient. After this it is to be wrung out and dried. When stuffs are to be galled, which have already received a colour, the operation must be performed in the cold, that the colour may not be injured. Cotton which has been alumed, acquires more weight in the galling, than that which has not undergone that process. Although alum adheres but in small quantities to cotton, it gives it a greater power of combining both with the astringent principle, and the colouring matter.

Of Flax.

As flax and hemp possess the same properties as far as relates to dyeing, the directions for one will succeed equally well for the other.

Flax must undergo several preparations before it is fit to receive the dye; the first is the watering, by which the fibrous parts of the plant become disposed to separate, so as to be rendered fit for spinning.

In watering, a glutinous juice, which holds the green colouring part of the plant in solution, and which is the medium of union between its cortical and ligneous parts, undergoes a greater or less degree of putrefaction, according to the mode of conducting the operation. This process is performed to the greatest advantage in pits situated on the banks of rivers, where the water may be changed often enough to prevent a degree of putrefaction that would injure the flax, and be prejudicial to the workmen, yet not so often as to hinder the degree of putrefaction necessary for rendering the glutinous substance soluble in water. After watering, the flax is dried, and the ligneous part separated by a mechanical operation.

Some have proposed the mixing a small quantity of caustic alkali with the water to increase its solvent power, but it appears, from Dr. Home's experiments, that the alkali retards the operation, and renders the flax liable to break. But after the watering and drying, alkaline substances dissolve the greatest part of the colouring matter, on account of the change it has undergone from the exposure to air and light, and the consequent absorption of oxygen.

The processes published by the Prince of S. Sever for obtaining fine dressed hemp, depend on the solution of the colouring matter by alkali. He directs that dressed hemp be lixiviated in a solution, of two parts soda and one of lime, then impregnated with soap, and kept in digestion; and afterwards well washed and hackled; but in this process only that portion of the colouring matter is dissolved, which would have been carried off by the first leys used in the beginning of the bleaching of the cloth.

The great fineness given to it probably cannot be produced but at the expence of the length and firmness of the filaments.

A clergyman of the department of Somme, in France, employs a process not liable to the inconveniences caused by leying the dressed hemp. He waters the hemp as soon as it is pulled, and separates the cortical part by a peculiar operation immediately after the watering, and having soaked it in a weak solution of black soap, he washes it with great care ; previous to the drying, the colouring matter, (which would afterwards have been soluble only in alkali) may be dissolved and extracted by water, with the addition of a small quantity of soap ; the hemp becomes much whiter, and divides better and more minutely, without, however, having been injured; and the leys preparatory to the bleaching become unnecessary. Thread and linen contain then a colouring substance, most of which may be extracted by simple leys, but there is a part of it, which is really combined with the vegetable fibres, and which can only be taken away by the destruction of its nature, effected by the combustion it undergoes during its combination with oxygen. Thread loses by the operations employed in bleaching from one-fourth to one third of its weight.

Flax or linen, intended to be dyed, must be subjected to the same operations of scouring, aluming, and galling which cotton undergoes.

The well-known greater difficulty with which linen, cotton, and silk, take dyes than wool, have been accounted for by supposing the pores of their fibres to be smaller; this, however, appears not to be true, from the greater quantity of colouring matter which they absorb. Unbleached cotton is always preferred for dyeing Turkey red, because in this state its colour is more permanent. The same thing is observed of raw or unscoured silk, which is found to combine more easily with the colouring matter, and to receive a more permanent colour in this state, than after it has been scoured and whitened. This has been accounted for also on mechanical principles, but it more probably is owing to the difference of the affinity, which exists between the colouring matter and the substance separated from the silk or cotton in bleaching or scouring. This substance acts probably the part of a mordant, and having a stronger affinity for the stuff and the colouring matter, than the stuff has for the latter, the colour communicated is more durable, when the silk or cotton is dyed in the unbleached or unscoured state.

Of the Processes for dyeing black.

According to the method described by Hellot, woollen cloth to be dyed black ought to have received the deepest blue tint, to have been washed in the river as soon as taken out of the vat, and to have afterwards been cleaned at the fulling-mill.

For an hundred pounds of the stuff, ten pounds of logwood, and ten pounds of Aleppo galls powdered, are put into a bag, and boiled for twelve hours in a middle-sized copper, with a sufficient quantity of water. One-third of this bath is put into another copper, with two pounds of verdegris, and into this the stuff is immersed, stirring it continually for two hours, and observing to keep the bath very hot, without letting it boil. The stuff is then taken out, and a portion of the bath equal to the former is put into the copper, with eight pounds of vitriol, or sulphate of iron. The fire is now to be diminished, and the bath suffered to cool for half an hour, whilst the vitriol dissolves; the stuff is then put in again, moved about well for an hour, and afterwards taken out to air. Lastly, the remainder of the bath is added, taking care that the bag be well pressed out. Fifteen or twenty pounds of sumach are now put in, and the bath is made to boil once, and then immediately stopped with a little cold water; two pounds more of the sulphate of iron are added, and the stuff is kept another hour. The stuff is now washed, aired, and again put into the copper, constantly stirring it for an hour: it is then carried to the river, well washed, and then fulled. When the water comes off clear, another bath is prepared with weld, which is made to boil for a moment, and after being cooled, the stuff is passed through it, to soften it, and render the black more firm. In this manner a very beautiful black is obtained, without making the stuff too harsh.

In general more simple processes are employed. Cloth previously dyed blue is merely boiled in a bath of galls for two hours ; it is then kept two hours in the bath of logwood and sulphate of iron without boiling, and afterwards washed and fulled. M. Hellot has also found the following method to succeed. For fifteen ells of deep blue cloth a bath is to be made with a pound and a half of yellow wood, five

pounds of logwood, and ten pounds of sumach. After having boiled the cloth in this bath for three hours, it is taken out, ten pounds of sulphate of iron are put into the copper, and the cloth is then put into it for two hours more. It is then aired, put into the bath again for another hour, and afterwards washed and fulled. This black is less velvety than that of the process first described.

Black may be dyed without a blue ground, and this is usually done for stuffs of low price. In this method the stuff is dyed of a brown, or root colour, with green walnut peels, or the root of the walnut tree: they are then blackened as above directed.

The proportions used by the English dyers are, for every hundred pounds of woollen cloth, dyed first of a deep blue, about five pounds of sulphate of iron, five pounds of galls, and thirty of logwood. They begin with galling the cloth, and then pass it through the decoction of logwood, to which the sulphate of iron has been added.

Some recommend fine cloths to be fulled with soap suds; but this operation requires an experienced workman to cleanse the cloth perfectly of the soap. Many advise to give the cloth a dip in a bath of weld when it comes from the fulling mill, which they say softens it, and fixes the black. Lewis says, the weld bath is totally useless when the cloth has been treated with soap-suds, though in other cases it may be of advantage. He ascribes its effects entirely to the alkali with which the dyers commonly prepare its decoction.

The leaves of the uva ursi may be employed instead of galls. They must be carefully dried in autumn, so that they may remain green. When they are to be used, 100 pounds of wool are boiled for two hours with sixteen pounds of sulphate of iron and eight of tartar: the day following the cloth is to be rinsed as after aluming: 150 pounds of uva ursi are then to be boiled in water for two hours, and after their being taken out, a little madder is to be added to the liquor, at the same time putting in the cloth, which is to remain there an hour and a half, or an hour and three quarters, after which it is to be rinsed in water. This process gives a pretty good black to blue cloth, but only a deep brown to white: the madder and tartar are supposed by Lewis to be useless.

Of dyeing Silk black.

It is necessary to cleanse silk that is to be dyed from the substance which adheres to it, called its gum; for though raw silk takes the dye with more facility, the colour is much less intense, and less durable, than when the silk is scoured; which is done by boiling it four or five hours with a fifth of its weight of white soap, after which it is beetled and carefully washed.

After being cleansed the silk must be galled; for which nearly three-fourths of its weight of galls are boiled for three or four hours, but their quantity must depend on the kind used; after boiling, the liquor is left at rest for two hours, that the galls may subside; the silk is then put into the bath, and left in it from twelve to thirty-six hours; it is then taken out, and washed in the river. Silk is capable of combining with much of the astringent matter of the galls, which attracts the colouring matter in proportion; therefore, when what is called an heavy black is required, it is allowed to remain longer in the gall liquor, the galling is repeated, and it is dipped in the dye a greater number of times, and left in it also for a considerable time. This method neither improves the dye nor the silk; but is merely used to give profit to the vender where silk is sold by weight.

Silk dyers preserve the black bath for silk for several years; when its effect becomes weak, it is renewed by adding more of its ingredients, and when the grounds accumulate too much they are taken out.

While the silk is preparing for dyeing the bath is heated, taking care to stir it occasionally, that the grounds, which fall to the bottom, may not acquire too much heat; it should never be heated so as to boil. Gum and solution of iron are added, in proportions depending on the different processes used; and when the gum is dissolved, and the bath near boiling, it is left to settle for about an hour. The silk is then dipped into it, being in general at first divided into three parts, each of which is put in successively. Each part is afterwards wrung gently three times, and hung up in the air after each wringing. The action of the air deepens the shade, and the wringing out the liquor prepares the silk to imbibe a fresh quantity.

After this the bath is again heated, and as much gum and sulphate of iron is put in as at first. The operation is repeated twice for light blacks; but for the heavy blacks three times; and after the last the silk is left in the bath for twelve hours. Sixty pounds of silk are commonly dyed at one operation.

After the dyeing is finished, the silk is rinced, by turning and shaking it in a vessel of cold water.

Silk when dyed is extremely harsh; to soften it a solution of four or five pounds of soap to every hundred pounds of silk is poured through a cloth into a large vessel of water; being well mixed, the silk is put in, and left about a quarter of an hour, after which it is wrung out and dried.

When raw silk is dyed, the galling is performed with cold liquor, to preserve its natural gum, and the elasticity which it causes. If the gall liquor is weak, the silk is left in it for several days; liquor that has been employed for other silk is generally used, and silk which has naturally a yellow hue is preferred. The raw silk thus prepared is dyed in the cold bath; it takes the dye readily, and the water in which other silk has been rinced suffices to communicate it, if sulphate of iron be added. It requires more or less time to lie in the rincings, according to their strength: sometimes three or four days are necessary, after which it is washed, and beetled once or twice; but not wrung, that its elasticity may not be injured. It may be dyed more speedily by shaking it over in the cold bath after galling, and then airing it, and repeating these operations a few times; after which it is to be washed and dried as above.

Macquer describes a more simple process, with which they dye velvet black, at Genoa; it is as follows:

For an hundred pounds of silk, twenty pounds of Aleppo galls, in powder, are to be boiled an hour in a sufficient quantity of water. The bath is then left to settle till the galls have fallen to the bottom, when they are taken out, and two pounds and a half of English vitriol of iron, twelve pounds of iron filings, and twenty pounds of gum, are put into a copper cullender with two handles, and immersed in the bath; the cullender is supported by sticks, that it may not touch the bottom, and an hour is allowed for dissolving the gum, which is occasionally stirred. If all the gum be dissolved in that time, three or four pounds more may be added. The cullender is only removed during the dyeing, and is put in again after it; the copper is kept hot the whole time, but not suffered to boil: the silk is galled with one-third of Aleppo galls, and left in the liquor six hours the first time, and twelve the second. The rest of the process is conducted in the common method. The gum is useful to keep the dye suspended in the liquor; but, it is probable, a smaller quantity might answer.

As galls are expensive, the following method has been used to lessen their consumption. The silk, after being boiled and washed in the river, is prepared by immersing it in a strong decoction of walnut peels till the colour is exhausted: it is then wrung, dried, and again washed in the river; after which it is left in a solution of two ounces of verdegris for every pound of silk, in cold water, for two hours, and then dipped in a strong decoction of logwood, which gives it a blue ground; it is then wrung out, dried, and washed in the river. The black bath for it is prepared by macerating two pounds of galls and three of sumach in twenty-five gallons of water, over a slow fire, for twelve hours; after straining, three pounds of sulphate of iron and as much gum arabic are dissolved in it. In this solution the silk is dipped at two different times, left two hours in the bath each time, and aired and dried after each dipping; it is then beetled twice at the river, dipped again, and left in the bath four or five hours; drained, dried, and again beetled twice as before. The heat of the bath must not exceed 122 Fahrenheit. Before each of the last dippings, half a pound of sulphate of iron, and as much gum arabic, should be added. Some think that the galls are only added to increase the weight, and that the sumach is sufficient for the dye.

Of dyeing Cotton and Linen black.

Cotton and linen do not take a black that will resist soap. The weakness of their affinity for iron renders a solution of it necessary, in dyeing them, in some acid, to which it has less attraction than to the sulphuric. This solution is prepared with iron and vinegar, or alegar from small beer or fermented worts, according as the country where the process is carried on affords them cheapest. (Pyrolignous acid, or the acid liquor procured in distilling spirits of turpentine, has also been used for the same purpose with success.) Pieces of old iron are thrown into the acid liquor, and they are allowed to remain in it six weeks or two months before it is used, that it may be fully saturated with the iron. This solution is called iron liquor in this country.

The process for dyeing linen and cotton thread black at Rouen is the following. It is first dyed sky blue; then wrung out and dried, (a deep blue is thought to be better); it is next galled, using four ounces

of galls to every pound of thread, and leaving them twenty-four hours in the gall liquor; after which they are wrung out and dried again. About five quarts of the iron liquor are then poured into a tub, in which the thread is worked by hand, pound by pound, for a quarter of an hour, and then wrung out and aired. This operation is repeated twice, adding each time a fresh quantity of the iron liquor, which should be carefully scummed; after this the thread is again aired, wrung out, washed at the river, and dried.

The thread receives the colour by immersion in the following bath. A pound of alder bark for every pound of thread is boiled an hour in a sufficient quantity of water; about half the bath that served for the galling, and half as much sumach as alder-bark, are then added, and the whole boiled together for two hours, and strained through a sieve. When the liquor is cold, the thread is put into it on sticks, and worked pound by pound, airing it from time to time; it is then let down into the bath again, left in it twenty-four hours, wrung out, and dried. To soften this thread, it is usual to soak and work it in the remains of a weld bath, that has been used for other colours, adding to it a little logwood.

At Manchester, the method used is, to first gall the stuff with galls or sumach, then to dye it in the iron liquor, and afterwards to dip it in a decoction of logwood and a little verdegris. This process is repeated till a deep black is obtained. It is necessary to wash and dry after each operation. The iron liquor for this process is frequently composed of infusion of alder-bark and iron.

M. Guhliche recommends highly the following solution of iron for dyeing linen and cotton. A pound of rice is to be boiled in twelve or fifteen quarts of water till wholly dissolved; the vessel that contains this liquor is to be half filled with old iron made red hot, and the whole to be exposed to the air and light for a week; an equal quantity of red-hot iron is to be thrown into as many quarts of vinegar, which is also to be exposed to the air and light; after some days, the two solutions are to be mixed together, and exposed to the air and light for another week. The liquor is then to be decanted, and kept in a close vessel for use.

The linen or cotton left in this liquor for twenty-four hours acquires a good black. If the liquor does not contain iron enough, a fresh portion should be used, which will produce a permanent black. This liquor may be advantageously substituted for sulphate of iron in dyeing wool or silk, which only require to be dipped in a decoction of logwood, after being taken out of the bath, to give them a beautiful black.

Berthollet mentions, that iron ought to be more oxygenated to unite with cotton or linen than with wool or silk; and that therefore the longer the iron liquor is exposed to the air the better. The place of galls, which bear an high price, is frequently supplied by oak-bark, oak saw-dust, sumach, the cups and husks of acorns, and other astringents.

Of dyeing Wool blue.

Blue may be dyed by woad alone, which would give a permanent, but not a deep blue; but if indigo be mixed with it, a very rich colour will be obtained.

The following is the method of preparing a blue vat, recommended by M. Quatremere. Into a vat about seven and a half feet deep, and five and a half broad, are thrown two balls of woad, weighing together about 400 pounds, first breaking them; thirty pounds of weld are boiled in a copper for three hours, in a sufficient quantity of water to fill the vat; when this decoction is made, twenty pounds of madder, and a basket full of bran, are added, and it is boiled half an hour longer. This bath is cooled with twenty buckets of water; and after it is settled the weld is taken out, and it is poured into the vat; all the time it is running in, and for a quarter of an hour after, it is to be stirred with the rake. The vat is then covered up very hot, and left to stand for six hours, when it is raked again for half an hour, and this operation is repeated every three hours.

When blue veins appear on the surface of the vat, eight or nine pounds of quick lime are thrown in. Immediately after the lime, or along with it, the indigo is put into the vat, being first ground fine in a mill with the least possible quantity of water. When it is diluted to the consistence of a thick pap, it is drawn off at the lower part of the mill, and thrown thus into the vat. The quantity of indigo depends on the shade of colour required. From ten to thirty pounds may be put to the vat now described.

If on striking the vat with the rake a fine blue scum arises, it is fit for use, after being stirred twice with the rake in six hours, to

mix the ingredients. Great care should be taken not to expose the vat to the air, except when stirring it. As soon as that operation is over, the vat is covered with a wooden lid, on which are spread thick cloths, to retain the heat as much as possible. Notwithstanding this care, the heat is so much diminished at the end of eight or ten days, that the liquor must be re-heated, by pouring the greater part of it into a copper over a large fire: when it is hot enough it is returned into the vat, and covered as before.

This vat is liable to two inconveniences; first, it runs sometimes into the putrefactive fermentation which is known by the fetid odour it exhales, and by the reddish colour it assumes. This accident is remedied by adding more lime. The vat is then raked, after two hours lime is put in, the raking performed again, and these operations are repeated till the vat is recovered; secondly, if too much lime is added, the necessary fermentation is retarded; this is remedied by putting in more bran or madder, or a basket or two of fresh woad.

When cloth is to be dyed, the vat is raked two hours before the operation, and to prevent it from coming in contact with the sediment, which would cause inequalities in the colour, a kind of lattice of large cords, called a cross, is introduced; when wool is to be dyed, a net with small meshes is placed over this. The wool or cloth being thoroughly wetted with clear water a little warm, is pressed out, and dipped into the vat, where it is moved about a longer or a shorter time, according as the colour is intended to be more or less deep, taking it out occasionally to expose it to the air; the action of which is necessary to change the green colour, given the stuff by the bath, to a blue. Wool and cloth dyed in this manner, ought to be carefully washed, to carry off the loose colouring matter; and those which are of a deep blue ought to be even fulled with soap, which cleanses them effectually without injuring the colour.

A vat which contains no woad is called an indigo vat; the vessel used for this preparation is of copper, into which is poured, according to its capacity, water; in forty pails of which, six pounds of potash, twelve ounces of madder, and six pounds of bran have been boiled; six pounds of indigo, ground in water, are then put in, and after raking it carefully, the vat is covered; a slow fire is to be kept up round it. Twelve hours after, it is filled, it is to be raked a second time, which is to be repeated at similar intervals of time, till it comes to a blue, which will generally happen in forty-eight hours. If the bath be well managed it will be of a fine green, covered with coppery scales and a fine blue scum. In this vat the indigo is rendered soluble in the water by the alkali instead of lime; the operation of dyeing with it is the same as the preceding.

Hellot describes two vats, in which the indigo is dissolved by means of urine. Madder is added to them, and in the one vinegar is put, in the other alum and tartar, of each an equal weight to the indigo. The quantity of urine ought to be very considerable. It is probable the indigo is dissolved in them by the ammonia formed in the urine. These vats are not so good as those before described; less work can be performed with them, so that they are adapted only to small dye-houses.

The colour dyed by a solution of indigo in sulphuric acid, is called Saxon blue, from having been discovered at Grossenhayn, in Saxony, by Counsellor Barth. M. Poerner, who has paid great attention to this preparation, directs four parts of sulphuric acid to be poured on one of indigo, in fine powder; the mixture is to be stirred for some time. After having stood twenty-four hours, one part of good dry potash in fine powder is added: the whole is to be again well stirred, and having stood twenty-four hours longer, more or less water is added gradually.

To dye Saxon blue, the cloth is prepared with alum and tartar; a greater or less proportion of indigo is put into the bath, according as the shade required is deep or light; for deep shades the stuff must be passed several times through the bath; light shades may be dyed after the deep ones, but they have more lustre when dyed in a fresh bath.

Of dyeing Silk blue.

Silk is dyed blue by the indigo vat before described. In general a larger proportion of indigo is put in than is there directed, but nearly the same quantities of bran and madder. Macquer says, that half a pound of madder for every pound of potash, makes the vat greener, and the colour more fixed. When the vat is come to, about two pounds of potash and three or four ounces of madder should be added; it should then be raked, and in four hours

it will be fit for dyeing. Its heat should be just what the hand can bear without pain. The silk is prepared for this bath by being boiled with thirty pounds of soap for every hundred pounds of silk, and being afterwards well cleansed from it by two or more beetlings in a stream of water. As the silk is very liable to take the colour unevenly, it is necessary to dye it in small portions; the workman dips each hank separately, and when he has turned it once or twice in the bath, he wrings it strongly over it, and airs it to turn the green colour to a blue; when the green is thoroughly changed, he throws it into some clear water, after which he wrings it several times with the pin. Care must be taken that the silk dyed blue dry speedily. In the winter, and in damp weather, it should be dried in a chamber heated by a stove, where it should be hung on a frame kept in constant motion. When the bath grows weak, a pound of potash, an ounce of madder, and an handful of bran well washed, are added. Indigo is also put in when it appears to be wanted. Some dyers use vats grown weak, to dye light shades, but fresh vats give a more beautiful and permanent colour.

As indigo alone cannot give a deep blue, the silk must be prepared by receiving a ground, or other colour, previous to dyeing. For the Turkey blue, a very strong archil bath is first given; and for the French royal blue a weaker one of the same kind. Cochineal is used also for the ground of another fine deep blue, which is more permanent. Verdegris and logwood are also used for a preparatory colour, but produce a blue that is not permanent. It might be rendered more lasting, by making the shade lighter than the intended in this bath, afterwards dipping it in the archil bath, and lastly in the blue vat.

When raw silk is to be dyed blue, that which is of a white colour should be chosen. It should be thoroughly soaked in water, and afterwards put into the vat in separate hanks, in the same manner as the scoured silk. In general, raw silk takes the dye more readily; wherefore, when it can be done, the scoured silk is put into the bath before it. If raw silk requires archil, or the other grounds mentioned, it should be treated as directed for silk in general.

The solution of indigo in sulphuric acid is also used for silk; the colour called English blue is produced by it. To give silk this colour, it is first dyed a light blue, and then dipped in hot water, washed in a stream, and afterwards left in a bath made with the sulphate of indigo, to which a little tin has been added, till the proper shade is obtained, or the bath exhausted.

The silk, before it is put into this bath, may be dipped in a solution of alum, in which it should remain only a very short time. Silk dyed in this manner, is free from the reddish shade given by the blue vat, and from the greenish cast of common Saxon blue.

Of dyeing Cotton and Linen blue.

The vat for dyeing cotton and linen blue, should contain, according to M. Pileur d'Apligny, about 120 gallons. The quantity of indigo used is generally from six to eight pounds. This indigo, after being pounded, is boiled in a ley drawn off clear from a quantity of lime equal to the indigo, and double its weight of potash. The boiling is continued till the indigo is thoroughly penetrated with ley, which should be carefully stirred all the while.

During the boiling of the indigo, an equal weight to it of quicklime is to be slacked; about twenty quarts of warm water are added, and in this is dissolved sulphate of iron, twice the weight of the lime. When the solution is compleated, the liquor is poured into the vat previously half filled with water. To this the solution of indigo is added, and the rest of the ley not used in boiling it. After this the vat must be filled up to within two or three inches of the brim, and be raked two or three times a day, till it is fit for dyeing; which generally happens in 48 hours, or sooner, according to the temperature of the air. Some add to this vat a little bran, madder, and woad.

In the process used at Rouen, which is simpler, 20 pounds of indigo, macerated for a week in caustic ley, which will float an egg, are ground in a mill; three hogsheads and an half of water are then put into the vat, and afterwards twenty pounds of lime. When the lime is thoroughly slacked, the vat is raked, and thirty-six pounds of copperas are put in. When the solution of this is complete, the ground indigo is put in through a sieve. On the same day it is raked seven or eight times; and after having stood 36 hours it is fit for dyeing.

Bergman recommends a still simpler bath, composed in the proportions of three drams of powdered indigo, three drams of copperas, and three drams of lime to two pints of water. This being well raked,

will, in the course of a few hours, be fit for use.

The solution of indigo in sulphuric acid, has been hitherto only used for dyeing wool and silk. The affinity of vegetable substances for indigo is not sufficiently strong to separate it from the sulphuric acid. It cannot therefore be employed to advantage in dyeing cotton or linen.

Attempts have been made to dye cloth with Prussian blue, but no method has yet been found to make this colour apply itself evenly, sufficiently certain and perfect for general use. This process deserves farther experiments, as the colour produced by it was very beautiful, and not liable to change, though exposed to all the vicissitudes of the air. But dust and rubbing injure it; and any touch of an alkaline liquor destroys it altogether. The process in which stuffs, previously impregnated with alum and copperas, are submitted to a solution of Prussian alkali, seems that most likely to succeed in diffusing the dye equally if improved by farther trials. Perhaps also a solution of caustic alkali might form a sufficient solvent for the Prussian blue, if ground with it, to admit of its being used in somewhat the same way as indigo.

Of dyeing Wool red.

Red colours are of various shades according to the nature of the colouring matters used. They all require mordants to render them permanent. The principle shades of red, are scarlet, crimson, and madder red.

Madder red is only employed for dyeing coarse woollen stuffs. To produce this red, the stuffs are first boiled for two or three hours with alum and tartar; they are then left to drain, slightly wrung out, and then put into a linen bag, and carried to a cool place, where they are to remain a few days. Some recommend five ounces of alum and one of tartar to each pound of wool; by encreasing the proportion of tartar, a deep and permanent cinnamon colour is produced instead of red; others advise to use only a seventh part of tartar. The madder bath should not exceed the temperature which the hand can bear; if let to boil, the colour will be different from that required. When the water is at this heat, Hellot recommends half a pound of grape madder to be put into it for every pound of wool to be dyed. It is to be well stirred before the wool is introduced, which should remain in it for an hour without boiling, except for a few minutes towards the end of this period, to make the combination of the colouring matter with the stuff more certain.

Madder reds are sometimes rosed, as it is called, with archil and brazil wood. In this way they become more beautiful and velvety, but the brightness thus given is not permanent.

When sulphate of copper is employed as a mordant, the madder dye yields a clear brown, somewhat inclined to a yellow; when solution of tin is used, the tint, according to Berthollet, is somewhat brighter than that obtained by the common method, but is always more inclined to yellow or fawn colour.

The red procured from kermes is finer than that from madder. The kermes is an insect found on a small species of live oak in Languedoc, Spain, Portugal, and other places; the females alone are used, they are of the shape and size of a pea, and of a reddish brown colour.

To dye woollen yarn with kermes, it is first boiled half an hour in water with bran; then two hours in a fresh bath, of one fifth of Roman alum, and one tenth of tartar dissolved in sour water; after this, it is left in a linen bag for some days in a cool place. To obtain a full colour, as much kermes as equals three fourths, or even the whole of the weight of the yarn is put into a warm bath, and the wool is put in at the first boiling. As cloth is less dense than wool, either spun or in the fleece, it requires one fourth less of the salts in boiling, and of the kermes in the bath.

The scarlet made by kermes was called scarlet in grain from the insect resembling a grain; it has much less bloom than that procured from cochineal; but is more permanent, and spots of grease may be discharged from it without injury. Since the art of heightening the colour of cochineal by solution of tin has been discovered, kermes has not been much used.

The scarlet produced by the preparation of cochineal just mentioned, is esteemed the finest and most splendid of any. Cloth to be dyed with it, is first submitted to the following bath: six pounds of tartar are infused in the water made warm, for every hundred pounds of the cloth; the bath is then stirred briskly, and when the heat has encreased a little more, half a pound of powdered cochineal is to be added, and the whole is then to be well mixed; immediately afterwards, five pounds of a very

clear solution of tin are to be poured in, and carefully mixed. When the bath begins to boil, the cloth is introduced, and briskly moved for two or three turns, after which it is moved more slowly. The boiling having continued for two hours, the cloth is taken out, exposed to the air, and carried to the river to be well washed.

The cloth is afterwards passed through a second bath for the reddening; to prepare which, the boiler is to be first emptied, and again filled with water; and when this has just reached the boiling point, five pounds and three quarters of cochineal, powdered and sifted, are to be added. These are to be well mixed; and sometime afterwards, when a crust that forms on the surface, opens of itself in several places, 13 or 14 pounds of solution of tin are poured in. Should the bath after that rise above the edge of the boiler, it may be cooled with a little water. The bath being well mixed, the cloth is put in, and turned quickly two or three times. It is then boiled in the bath for an hour, taking care to keep it under the surface. It is afterwards taken out, exposed to the air, and when cool washed in the river, and dried.

Some dyers do not remove the cloth out of the first bath; but merely refresh it and perform the operation of reddening in the same bath. In this method the infusion of cochineal, made in a separate vessel, and mixed with a proper proportion of tin, is added. By conducting the process in this way, the scarlet is supposed to be equally fine, and there is a considerable saving of time and fuel.

To give scarlet the bright lively red, called fire colour, a yellow tinge is communicated to the cloth by boiling fustic in the first bath, or by adding a little turmeric to the cochineal. A larger proportion of the solution of tin also produces this yellow shade, but it renders the cloth harsh, and limits the action of the colouring matter.

Dr. Bancroft recommends a method of dyeing scarlet, in which a much smaller portion of cochineal produces an equal effect. He conceived scarlet from his experiments to be a compound colour, caused by about three-fourths of crimson or rose colour, and one-fourth of pure bright yellow. He therefore supposed that when the natural crimson of the cochineal is made scarlet, by the usual process, a fourth of the colouring matter of the cochineal must be changed from its natural crimson to a yellow colour by the action of the solution of tin. For this reason he introduced a bright yellow dye into the bath with the cochineal, and reduced the quantity of this more expensive ingredient. He also found that a mixture of two pounds of sulphuric acid with about three pounds of muriatic acid, poured on fourteen ounces of granulated tin, with exposure to heat, produced a solution of tin, that had twice the effect of the common nitro muriatic solution, at less than a third of the expense, and which raised the colours more, without producing a yellow shade. For the yellow dye Dr. Bancroft used quercitron bark. His process for dyeing scarlet, by the use of this substance and the above preparation of tin, is as follows:

An hundred pounds of cloth are to be put into a tin vessel, nearly filled with water, in which about eight pounds of the murio-sulphuric solution of tin have been previously mixed. The liquor is made to boil, and the cloth is turned through it by the winch for a quarter of an hour in the usual manner. The cloth is then taken out, and four pounds of cochineal, with two pounds and a half of quercitron bark in powder, put into the bath and well mixed. The cloth is then returned into the liquor, which is then made to boil, and the operation is continued, as usual, till the colour be duly raised, and the dyeing liquor exhausted, which will usually happen in about fifteen or twenty minutes; after which the cloth may be taken out and rinsed as usual. In this method the labour and fuel necessary for the second bath are saved; the operation is finished in much less time; all the tartar will be saved, as well as two-thirds of the expense of the solvent for the tin, and, at least, one-fourth of the cochineal usually employed; and the colour produced will not be inferior, in any respect, to that dyed with so much more expense and trouble in the ordinary way; and, moreover, looks much better than it by candle light.

A rose colour may be readily and cheaply dyed by the above process, by only omitting the quercitron bark.

Crimson is produced either by dyeing the wool this colour at once, or by first dyeing it scarlet and then changing the shade to that required. To dye crimson by a single process, a solution of two ounces and a half of alum, and an ounce and half of tartar, are employed in the boiling for every pound of the stuff, for each of which also an ounce of cochineal is to be afterwards used in dyeing it. It is customary to employ solu-

tion of tin, but in smaller proportion than for dyeing scarlet. To render the crimson deeper and give it more bloom, archil and potash are frequently used, but this bloom is extremely fugacious.

To produce a crimson from a scarlet, the alkalies, alum, and earthy salts are used, all of which have this effect. Crimson is the natural colour of the cochineal, and to produce it from a stuff dyed scarlet, the stuff is boiled for an hour in a solution of alum, the strength of which is to be regulated by the depth of shade required.

Of dyeing Silk red.

The red colour obtained from madder does not possess sufficient brightness for silk; one of the best processes for its use is the following of M. Guhliche: for every pound of silk, four ounces of alum and one of solution of tin are to be mixed with water; when the liquor has become clear it is decanted, and the silk is soaked in it for twelve hours, after which it is immersed in a bath of half a pound of madder to each pound of silk, softened by boiling with an infusion of galls in white wine. The bath is to be kept moderately hot for an hour, and then made to boil for two minutes. The silk is then to be taken out, washed in a stream of water, and dried in the sun. The colour thus obtained is very permanent. By leaving out the galls it is clearer.

Crimson produced on silk by cochineal is called grain crimson, to distinguish it from a colour called false crimson, dyed with Brazil wood. For the grain crimson, the silk being well cleansed from soap at the river, is to be immersed for a night in alum liquor of the full strength; it is then to be washed, and twice beetled at the river. The bath is prepared by filling a long boiler two-thirds with water, to which are added, when it boils, from half an ounce to two ounces of powdered white galls for every pound of silk. When it has boiled for a few moments, from two to three ounces of cochineal, powdered and sifted, are put in for every pound of silk, and afterwards one ounce of tartar for every pound of cochineal. When the tartar is dissolved, one ounce of solution of tin is added for every ounce of tartar. Macquer recommends this solution of tin to be made by dissolving six ounces of fine grain tin, with two ounces of sal ammoniac, in a pound of nitric acid, diluted with twelve ounces of water. When these ingredients are mixed together, the boiler is to be filled with cold water, the proportion of which, for every pound of silk is about eight or ten quarts. In this bath the silk is to be immediately immersed, and turned on the winch till it appears of an uniform colour; the fire is then encreased, and the bath is kept boiling for two hours, taking care to turn the silk occasionally; the fire is afterwards put out, and the silk immersed in the bath, where it is suffered to remain a few hours longer; it is then taken out, washed at the river, twice beetled and dried.

To obtain other shades of red, the above processes must be varied. If, after the silk has been wrung out of the solution of tin, it is steeped for a night in a cold solution of alum, in the proportion of one ounce to a quart of water, wrung, dried, then washed and boiled with cochineal, it will appear of a pale poppy colour. But a fine poppy-red may be procured by steeping it twelve hours in the solution of tin, diluted with eight parts of water, then leaving it all night in the solution of alum, after which it is to be washed, dried, and passed through two baths of cochineal, taking care to add to the second bath a small quantity of sulphuric acid.

The colour that comes nearest to scarlet has been produced on silk, by first dyeing it crimson and then dyeing it with carthamus, and afterwards submitting it to a yellow bath without heat. The colour thus given is very fine, but the dye of carthamus is not permanent. In Dr. Bancroft's process, the silk is soaked for two hours in a solution of tin, in the murio-sulphuric acid, after which it is wrung out and dried partially. It is then to be dyed in a bath prepared with four parts of cochineal and three of quercitron bark. In this way a colour approaching to scarlet is obtained. To give the colour more body, the immersion may be repeated in the solution of tin, and in the dyeing bath: the brightness of the scarlet is increased by the addition of carthamus. A lively rose colour is produced by omitting the quercitron bark, and dyeing with the cochineal alone.

Of dyeing Cotton and Linen red.

To dye cotton and linen red, madder is used; which cotton attracts more strongly than linen. The madder-red of cotton is distinguished into two kinds, the one is called simple madder-red; the other, which is much brighter, is called Turkey, or Adrianople red.

The process used at Rouen for the sim-

ple madder-red is as follows. The cotton must be scoured, galled with one part of galls to four of cotton, and then alumed with four ounces of Roman alum to one pound of cotton, and an equal weight of water: to the solution of alum one twentieth part of a solution of soda, consisting of half a pound of soda to a quart of water, must be added. When the cotton is taken out of this mordant, it is slightly wrung with the pin and dried; the colour is more beautiful as the drying is slow; twenty pounds of cotton are usually dyed at once, but ten would be better, because when many hanks are dyed at a time it is difficult to make the colour equal. To prepare the bath for ten pounds of cotton, about two hundred and twenty quarts of water should be heated in a copper, and when almost too hot for the hand, six pounds of good Dutch grape madder are to be carefully dispersed through it. When it is well mixed, the cotton is to be immersed, hank by hank, on sticks. When all the cotton is in, it is to be well worked, and the hanks turned on the sticks for three quarters of an hour, the bath being kept constantly at the same degree of heat without boiling; at the end of this time the cotton is to be taken out and left on the edges of the copper, a pint of the above ley of soda is to be added to the bath, and the cotton to be put into it again and boiled from ten to fifteen minutes: lastly, it is to be taken out, left to drain, wrung, washed in a stream of water, and wrung on the pin a second time.

Two days afterwards the cotton receives a second maddering in the proportion of eight ounces of madder to the pound of cotton, and is worked as in the first maddering, except that no ley is added, and that well-water is used for the bath: after this the cotton is left to cool, washed, wrung, and dried. M. d'Apligny recommends, instead of receiving two madder baths, that the cotton be alumed twice, and then dyed in a single bath only. This red is made more lively by soaking the cotton, pound by pound, in a bath of warm water, into which about a pint of the ley is poured; it is then wrung and dried; then washed in a stream of water, and spread on the grass, where the red brightens more than by any other operation.

The Turkey red possesses a degree of brightness much superior to the common madder red, and more powerfully resists the action of alkalies, alum, soap, and acids. The processes used in Turkey for this red are very complicated and tedious, some taking a month to perfect, the best of them are detailed in Berthollet's treatise on the "Elements of Dyeing." Their efficacy depends chiefly on the impregnation of the cotton with animal matter, which is mostly done by fish-oil and sheeps' dung.

One of the best processes for the Adrinople red, practised in our part of the world, is that at Glasgow, introduced by M. Papillon, at the expense and at the instance of the commissioners for manufactures in Scotland, and which is as follows. A ley is prepared for 100*lb.* of cotton, from 100*lb.* of Alicant barilla, 20*lb.* of pearl-ashes, and 100*lb.* of quick-lime, strong enough to bear an egg. A weaker sort is also prepared of the strength marked by two degrees of the French hydrometer, the first kind being of six degrees. (A saturated solution of common salt marks 60°, and soft-water 0° on this instrument.) The pearl-ashes are dissolved in ten pails of soft-water, of four gallons each, and the lime in fourteen pails; the liquors are let to stand till quite clear, and then ten pails of each are mixed together. In this the cotton is boiled five hours, washed in running-water, and dried: it is then submitted to what is called the grey bath.

For the grey bath, in twenty pails of the strong ley are mixed two pails of sheeps' dung, two quarts of oil of vitriol, and one pound of gum arabic, and one pound of sal ammoniac, previously dissolved in a proper quantity of the weak ley; and, lastly, twenty-five pounds of olive oil well mixed with two pails of the weak ley. The whole being well mixed, the cotton is trodden down in it till it is well soaked, left thus for twenty-four hours, and then wrung hard and dried. This operation is repeated a second and a third time, after which the cotton is well washed and dried.

The white bath, in which the cotton is next placed, is managed in every particular as the preceding, except that the sheeps' dung is omitted in it.

The gall bath, in which it is then put, is prepared by boiling twenty-five pounds of bruised galls in ten pails of river-water until four or five are boiled away; the liquor is strained into a tub, and cold water is poured on the galls in the strainer. In this liquor, made milk warm, the cotton is to be dipped hank by hank, and left to steep in it twenty-four hours. It is then wrung carefully, and equally, and dried well without washing.

For the first alum bath, twenty-five pounds of Roman alum are dissolved in fourteen pails of warm water, without making it boil; the liquor is well skimmed, two pails of the strong ley are added, and the whole is let to cool till it is luke warm. In this bath the cotton is dipped, handled hank by hank, left to steep twenty-four hours, then wrung equally, and dried well without washing.

The second alum bath, to which it is next submitted, is managed exactly like the above; but after the cotton is dry it is steeped six hours in the river, and then washed and dried.

Into the dyeing bath it is next put, by ten pounds at a time; which is prepared by mixing two and a half gallons of ox blood with twenty-eight pails of milk-warm water, adding twenty-five pounds of madder, and stirring all well together.

The ten pounds of cotton, previously put on sticks, is dipped into this liquor, and turned constantly for one hour, during which the heat is gradually encreased till the liquor begins to boil at the end of the hour. The cotton is then sunk in it, boiled gently one hour longer, and then washed and dried.

For the next ten pounds of cotton, so much of the boiling liquor is taken out, that what remains may produce a luke-warm heat with the fresh water with which the copper is again filled up, and then the dyeing liquor is made up as above.

For the fixing bath, five or six pails of the grey bath liquor, and as much of the white bath liquor are mixed together; in this the cotton is trodden down, left to steep six hours, and then wrung moderately and equally, and dried without washing.

The brightening bath, is prepared by dissolving carefully and completely ten pounds of white soap, in sixteen or eighteen pails of warm water: if any little bits of the soap remain undissolved, they will make spots in the cotton; four pails of the strong ley are added, and well stirred in. In this liquor the cotton is sunk, kept down with cross sticks, covered up, and boiled gently two hours; it is then washed and dried, which completes the process.

For the common madder red Mr. Wilson advises acetite of alumen to be used as the mordant, instead of alum. The cotton in his process is galled, dried, then impregnated with the acetite of alumen diluted with hot water; dried a second time, maddered, washed, and dried again.

The scarlet colour communicated to cotton by cochineal is far from being permanent; but if it is desired, Dr. Bancroft recommends the cotton to be first steeped for half an hour in a diluted solution of murio-sulphate of tin, to wring it, and then plunge it into water in which as much potash has been dissolved as will neutralize the acid adhering to the cotton, so that the oxide of tin may be more copiously fixed on its fibres; the stuff rinsed in water is then to be dyed with cochineal and quercitron bark, in the proportion of four pounds of the former to two of the latter. A full bright colour is thus given, that will resist soap and the air.

With acetite of alumen, used as a mordant, cotton dyed with cochineal receives a beautiful crimson; it will bear washing and the weather for some time; but is not permanent. Dr. Bancroft thinks, that a small portion of cochineal added in dyeing madder reds, on the finer cottons, would be highly advantageous.

Of dyeing Wool yellow.

Weld is most commonly used in dyeing yellow. For the preparatory bath for dyeing wool this colour, Hellot directs four ounces of alum, and only one of tartar, to be used for every pound of wool.

For the dyeing bath, the weld is boiled inclosed in a thin linen bag, in the proportion of from three to six pounds for every pound of cloth; it is kept from rising by a wooden cross: some dyers add a little quicklime and ashes, which heighten the colour, but render it less capable of resisting acids. Lighter shades of colour may be obtained by dyeing after deeper ones, adding water after each dipping, and keeping the bath at a boiling heat. These are not so lively as when fresh baths are used with a suitable proportion of weld. Alum renders the shade paler and more lively, tartar still paler, but sulphate of iron causes it to incline to brown.

Poerner recommends a similar preparation for this dye to that for scarlet, by which the colour will be brighter, more permanent, and lighter.

Dr. Bancroft states quercitron bark to be the cheapest and best substance for dyeing wool yellow. For its use the following process is directed. The bark, with an equal weight, or one-third more of alum, is to be boiled for about ten minutes, in a suitable proportion of water; the stuff previously scoured is then immersed in the

bath. The higher colours are dyed first, and afterwards the pale-straw colours. The colour may be considerably heightened, by passing the unrinsed stuff a few times through hot water to which one pound and a half of clean powdered chalk has been added for every hundred pounds of stuff.

The bark in boiling should be tied up in a thin linen bag, and suspended in the liquor, after having been first reduced to powder. This is the cheapest and quickest process; but the colour will be fuller and more permanent, if the stuff is first boiled for an hour and a quarter in a bath of a sixth or an eighth of its weight of alum, dissolved in a proper quantity of water; and be then, without being rinsed, immersed in the dyeing bath, formed by a weight of powdered quercitron bark equal to that of the alum, tied up in a linen bag in clean hot water: it is to be turned through the boiling liquor in the usual manner, till its colour appears sufficient. One pound of clean powdered chalk, for every hundred pounds of stuff, is then to be mixed with the dyeing bath, and the operation is to be continued for eight or ten minutes longer. The addition of the chalk heightens and brightens the colour.

To give a beautiful orange-yellow to woollen stuffs, ten pounds of quercitron bark tied up in a bag, for every hundred pounds of stuff, are to be put into the bath with hot water. At the end of six or eight minutes, an equal weight of murio-sulphate of tin is to be added, and the mixture to be well stirred for two or three minutes. The cloth first scoured, and completely wetted, is then immersed in the dyeing liquor, and briskly turned for a few minutes; by this process the highest yellow may be produced in less than fifteen minutes.

High shades of yellow are given by young fustic and nitro-muriate of tin, but they are less permanent, less beautiful, and more costly than those obtained from the above bark.

Of dying Silk yellow.

To dye silk a plain yellow, in general weld alone is used. The silk is first scoured with soap, in the proportion of twenty pounds of soap to the hundred of silk, then alumed, and washed.

The dyeing bath is prepared with two pounds of weld to every pound of silk, which having boiled for fifteen minutes, is to be passed into the vat through a sieve or cloth. When the temperature is as high as the hand can bear, the silk is introduced, and turned, until it acquires an uniform colour; during this time the weld is to be boiled a second time in fresh water; one half of the first bath is then taken out, and its place supplied with a fresh decoction. The temperature of the fresh bath may be a little higher than that of the former, but should not be too great, lest the colour already fixed be dissolved. The stuff is to be turned as before, and then taken out of the bath. Soda is to be dissolved in a part of the second decoction, and a larger or smaller quantity of the solution is to be added to the bath, according to the intensity of the shade wanted. The colour is examined by taking out a skein and wringing it.

To produce shades having more of a gold colour, anotta is added in proportion to the depth of colour required. Lighter shades, such as pale lemon colour, are obtained by previously whitening the silk, and regulating the proportion of the ingredients of the bath by the shade required. To give a yellow, with a green tinge, a little indigo is added to the bath, if the silk has not been previously azured; to prevent the greenish shade being too deep, the silk should be more slightly alumed than usual.

Dr. Bancroft asserts that all the shades of yellow can be given at a cheaper rate by quercitron bark than by weld. To dye with this bark, a quantity of it powdered, and inclosed in a bag, in proportion to the shade wanted, from one to two pounds for every pound of silk, is put into the vat while the water is cold. Heat is applied, and when the bath is rather more than blood warm, or of the temperature 100°, the silk, after being first alumed, is immersed and dyed in the usual way. A deeper shade may be given by adding a small quantity of chalk or pearl-ashes towards the end of the operation. To produce a more lively yellow a small portion of murio-sulphate of tin may be employed, but it should be used cautiously as it is apt to diminish the lustre of the silk.

To dye silk of an aurora or orange colour, after having been properly scoured, it may be immersed in an alkaline solution of anotta, the strength of which is to be regulated by the shade required. The temperature of the bath should be between that of tepid and boiling water. When the desired shade is obtained, the silk is to be twice washed and beetled, to free it from the superfluous colouring matter, which would

injure the beauty of the colour. When raw silk is to be dyed, that which is naturally white should be selected, and the bath should be nearly cold; for otherwise the alkali, by dissolving the gum of the silk, destroys its elasticity. Silk is dyed of an orange colour by anotta, but if a redder shade be wanted, it is procured by alum, vinegar, or lemon juice. These colours are beautiful, but do not possess permanency.

Of dying Cotton and Linen yellow.

In dyeing cotton or linen yellow, the first operation is to scour the stuff with a ley prepared from the ashes of green wood; it is then washed, dried, and alumed with one fourth of its weight of alum: after twenty-four hours, it is taken out of the alum liquor, and dried without being washed. A weld bath is then prepared, by an infusion of a pound and a quarter of weld for every pound of the stuff, and in this it is dyed by being turned and wrought, till it has acquired the proper shade. It is then taken out of the bath, and soaked for an hour and a half, in a solution of a quantity of sulphate of copper equal to one fourth of the weight of the stuff; it is then thrown, without being washed, into a solution of soap in the same proportions: after being well stirred, it is boiled in it, for nearly an hour, and then well washed and dried.

If a deeper colour is wanted, the stuff is not alumed, but two pounds and a half of weld are used for every pound of the stuff, for each of which a dram of verdegris mixed with a part of the bath is added; in this bath it is dipped and worked, till it has acquired an uniform colour; it is then taken out of the bath, and a little ley of soda poured in; after this it is again returned into the bath, kept there a quarter of an hour, and then taken out, wrung, and dried. Other shades of yellow may be obtained by varying the proportion of the ingredients; a lemon colour may be procured by using only one pound of weld for every pound of cotton, and by diminishing the proportion of verdegris, or using alum as a substitute.

Dr. Bancroft directs a method for dyeing cotton yellow, which he asserts to be much cheaper, and which appears better in several respects, particularly as to the mordant. It is as follows:

The mordant to be used is the acetite of alumen, formed by dissolving one pound of sugar of lead, and three pounds of alum, in a sufficient quantity of warm water. In this liquor, heated to 100°, the cotton is to be steeped two hours, after being first properly rinsed. It is then taken out and moderately pressed over a vessel, to prevent waste of the liquor. It is then dried in a stove heat, and after being again soaked in the aluminous solution, is wrung out a second time and dried: it is then barely wetted with lime water, and afterwards dried; and if a full and bright colour is wanted, it may be necessary to soak the stuff again in the diluted aluminous mordant, and after drying, to wet it a second time with lime-water: after it has been soaked for the last time, it should be well rinsed in clean water, to separate the uncombined portion of the mordant, which might injure the application of the colouring matter. By the use of the lime-water, a greater proportion of alumen combines with the stuff, as well as a certain portion of lime.

In the preparation of the dyeing bath, from twelve to eighteen pounds of quercitron bark are inclosed in a bag, for every hundred pounds of the stuff, varying the proportion according to the shade required. The bark is put into the water while cold, and immediately after the stuff is immersed, and agitated or turned in it for an hour or an hour and a half, during which the water should be gradually heated, and the temperature raised to 120°. At the end of this time the heat is increased, and the dyeing liquor brought to a boiling temperature; but at this temperature the stuff must only remain in it for a few minutes, because otherwise the yellow assumes a brownish hue. The stuff having thus acquired a sufficient colour, is taken out, rinsed, and dried.

Many attempts have been made to imitate the shade of yellow which nankeens possess; but none have hitherto succeeded, so as to produce a colour whose difference from the real nankeen could not be in general distinguished at first sight; or in the very few instances where this was at all doubtful, a little wear soon betrayed the deception. Chaptal has recommended a colour procured from salt of iron for this purpose; and in the processes of others, iron in general has been the colouring substance used; but a colour from iron has the evident defect of getting black stains from the least touch of any astringent liquor, to which it is perpetually liable wherever tea is used. It is therefore useless to insert receipts for a colour, which never yet came sufficiently near what it was intended, to

produce the least competition in the market with the real article.

Nankeen is made of cotton, whose colour is naturally such as we see it; some of the best grows in Bhaugalpore in the East Indies; it would be an object well worth the attention of the cotton planters in the West India islands, to get over plants or seeds of this species of cotton, to raise it for the English market. Perhaps the Bhaugalpore cotton might be imported from the East cheap enough for the use of our manufacturers, which would save the nation much of the large sums that go out of it annually for the purchase of nankeens.

Of dyeing Wool green.

Having given an account of the most approved processes for dyeing the four simple colours, black, red, blue, and yellow, we now proceed to the compound colours; which are so called because in general they are produced in dyeing by mixtures of the simple colours, though in a few instances substances are found which produce some of the compound colours without addition.

To dye woollen green, either a blue or a yellow dye may be first given to it; but the first is generally done, because the yellow dye of the stuff would injure the blue bath. The intensity of the blue must be proportioned to the shade of green required. When the blue dye is given, the yellow is communicated by some of the processes described. The cloth having first got the proper ground, is washed at the fulling mill, and boiled as for the common process of welding; but when the shade is to be light, the proportion of salts should be less. In this case the quantity of weld used should also be less, but for all other shades it should be greater than for dyeing simple yellow.

Sulphate of indigo is employed for the greens called Saxon greens. Dr. Bancroft directs for this dye, that from six to eight pounds of quercitron bark, enclosed in a bag, should be put into the bath for every hundred pounds of cloth, with only a small proportion of water, just as it begins to grow warm. When the water boils, six pounds of murio-sulphate of tin should be put in, and a few minutes after, about four pounds of alum; these having boiled five or six minutes, cold water should be added, and the fire be diminished, so as to bring down the heat of the liquor nearly to what the hand is just able to bear; immediately after this as much sulphate of indigo is to be added, as will suffice to produce the shade of green required, taking care to mix it thoroughly with the bath. The cloth, previously scoured and moistened, should then be expeditiously put into the liquor, and turned very briskly through it for a quarter of an hour, that the colour may apply itself evenly in every part. By these means very full, even, and beautiful greens may be dyed in half an hour; but during this space it is best to keep the liquor a little below the boiling heat.

Of dyeing Silk green.

The silk is first scoured, as for other colours; and for light shades the scouring must be as complete as for blue. It is then first dyed yellow in small parcels, (after being well alumed, and slightly washed at the river) by carefully turning it in the weld bath. When it has acquired the proper shade of yellow for the green required, which is known by trying a pattern in the blue vat, it is taken out, washed, and then immersed in the blue vat. A deeper colour is given, and the shade varied, by adding a decoction of logwood, fustic, or anotta to the yellow bath, after the weld has been taken out. For light shades a lighter ground is given.

For Saxon green from sulphate of indigo, the silk is prepared by boiling as for welding, and afterwards washed. Then fustic in chips, enclosed in a bag, is put into the same bath, boiled for an hour and a half, and then taken out, and the bath let to cool till the hand can bear its heat. A pound and a quarter of indigo is added for every eighteen yards of stuff; the stuff should be first turned quickly, and afterwards more slowly, and it should be taken out before the bath boils.

In Dr. Bancroft's process for the Saxon green, four pounds of quercitron bark, three pounds of alum, and two pounds of murio-sulphate of tin, are infused in a proper quantity of water: the bath is boiled ten or fifteen minutes, and when cooled till the hand can bear it, is fit for use: by adding different proportions of sulphate of indigo, various beautiful shades of green may be obtained. Care must be taken to keep the bath constantly stirred to prevent the colouring matter from subsiding. Those shades which are intended to incline to yellow should be dyed first; and by adding sulphate of indigo, the green having a shade of blue may be obtained.

Of dyeing Cotton and Linen green.

Cotton and linen are scoured in the usual way, and then first dyed blue; after being cleaned, they are dipped in the weld bath to produce a green colour. The strength of the blue and yellow is proportioned to the shade of green wanted. But as it is difficult to give cotton velvet an uniform colour in the blue vat, it is first dyed yellow with turmeric, and the process completed by giving it a green by sulphate of indigo.

The different shades of olive, and drakesneck green, are given to cotton thread, after it has received a blue ground, by galling it, dipping it in a weaker or stronger bath of iron liquor, then in the weld bath, and afterwards in the bath with sulphate of copper; the colour is lastly brightened with soap.

Yellow colours are rendered more intense by means of alkalies, sulphate of lime, and ammoniacal salts, but become fainter by means of acids, solutions of tin, and alum.

Of dyeing Wool purple, violet, and lilac.

Violet, purple, lilac, dove colour, and a great variety of other shades, are produced by the mixture of red and blue, according to the proportions of the substances employed. For violets, a deep blue ground is given, and for purples a lighter blue; in lilacs and similar colours, both the red and blue are light.

For violets and purples, the stuff should first be dyed a light blue, not deeper than sky blue; it is then boiled with alum and two-fifths of tartar, and is afterwards dipped in a bath composed of nearly two-thirds the quantity of cochineal required for scarlet, with the addition of tartar. The same process is followed as for dyeing scarlet. It is common to dye these colours after the reddening for scarlet, making such additions of cochineal and tartar, as the intensity of the shade may require.

For lilacs, dove colours, and other lighter shades, the stuff may be dipped in the bath which has served for violet and purple, and is somewhat exhausted, taking care to add a proper quantity of alum and tartar. For reddish shades, such as peach-blossom, a small proportion of solution of tin is added. It may be observed in general, that though the proportion of cochineal is less in lighter shades, the quantity of tartar must not be diminished.

A less expensive process is recommended by M. Poerner for these colours: he prepares the stuff by boiling it an hour and a half, with three ounces of alum for every pound of it, and leaving it a night in the liquor after it is cold; he makes the bath with an ounce and a half of cochineal, and two ounces of tartar, for every pound of stuff, boiling it three quarters of an hour, and then adding two ounces and a half of sulphate of indigo in the above proportion to the stuff; he stirs the bath and makes it boil gently for a quarter of an hour, and thus obtains a very beautiful violet; he increases and diminishes the indigo in all proportions from five drams to five ounces, to each pound of stuff, according to the shade wanted; he also reduces the quantity of cochineal, but never below an ounce to the pound, because the colour would then be too dull: he varies the proportion of tartar, and prepares the stuff with different quantities of solution of tin.

A purple colour, as well as some other shades, may be given to wool by logwood, with the addition of galls, but the colours thus obtained are not permanent. M. Decroizille discovered a process by which a durable dye may be procured from logwood, of which the following is an account. The mordant used was a solution of tin in a mixture of sulphuric acid, common salt, and water; to which were added red acidulous tartrite of potash, and sulphate of copper.

If the wool is to be dyed in the fleece, it will require a third of its weight of this mordant, but for cloth a fifth will be sufficient. A bath is to be prepared as hot as the hand can bear, with which the mordant is to be well mixed, and the stuff is to be dipped in it and stirred; the same temperature is to be kept up for two hours, and increased a little towards the end; after which the stuff is to be taken out, aired, and well washed. A fresh bath of pure water is prepared at the same temperature, to which a sufficient quantity of the decoction of logwood is added: in this the stuff is immersed and stirred; the heat is then increased to the boiling temperature, and continued so for fifteen minutes, after which the stuff is taken out, aired, and carefully rinsed. If the decoction of one pound of logwood has been used for every three pounds of wool, and a proportionate quantity for stuffs that require less, a fine violet colour is produced; to which a sufficient quantity of Brazil wood imparts the shade known in France by the name of *prune de Monsieur*.

The colours produced by logwood, Brazil, fustic, and yellow wood, may be fixed on wool to advantage by the last mentioned mordant. The alkali of the soap used in fulling is apt to change the colour given by the two first of these substances, but this is remedied by a slightly acid bath a little hot, called the brightening bath, for which sulphuric acid is the best; the colour after this is as deep, and frequently much brighter, than before the change. Wool dyed by means of this mordant, is said to admit of being spun into a finer and more beautiful thread than that prepared by alum. If the sulphate of copper is omitted, more beautiful colours are produced by fustic and yellow wood, as well as by weld. An orange red is given by madder with it, but not so deep as with a similar quantity of alum. When sulphate of copper is omitted, the wool is said to be much harsher, and the mordant prepared without it yields but indifferent colours with logwood, and in particular with Brazil wood.

Of dyeing Silk violet or purple.

Silk may be dyed violet in two different modes, the colour produced by the one is called the fine colour, and that by the other the false, the latter of which is dyed by means of archil or Brazil wood. When the fine colour is required, the silk must first be passed through a cochineal bath, and afterwards be dipped in the blue vat. The preparation and dyeing of silk with the cochineal, are the same as for crimson, with the omission of tartar and solution of tin, by which the colour is heightened. The quantity of cochineal made use of, is always proportioned to the required shade, whether it be more or less intense; but the usual proportion for a fine violet colour, is two ounces of cochineal for each pound of silk. When the silk is dyed, it is washed at the river, twice beetled, dipped in a blue vat more or less strong in proportion to the depth of the shade of violet wanted, and then washed and dried with the precautions which all colours require that are dyed in this vat. If the violet is to have greater strength and beauty, it is usual to pass it through the archil bath; without this light shades would be too dull.

When silk has been dyed with cochineal as above directed, only a very light shade is requisite for purple; the shades which are deepest are dipped in a weak blue vat, but those which are to be lighter, it is sufficient to dip in water incorporated with a small quantity of the liquor of the vat, because in the vat itself they would acquire too deep a tinge of blue, however weak it might be. The light shades of this colour, as gillyflower, peach-blossom, &c. are produced in this manner, by diminishing the quantity of cochineal.

The false violet colour of the greatest beauty, is given to silk by archil, of the various ways used for producing it; the bath of which is to have its strength proportioned to the colour required. The silk having been beetled at the river, after scouring, is turned in the archil bath on the skein sticks; and when the colour is deemed sufficiently deep, a pattern is tried in the blue vat to ascertain whether it takes the violet colour intended to be produced. If the shade is of the proper depth, the silk is beetled at the river, and dipped in the vat in the same way as for the fine violet colours; and less either of the blue or of the archil colour is given, according as the violet is intended to have the blue or red shade predominant.

A violet colour may be imparted to silks by immersing them in water impregnated with verdigris, as a substitute for aluming, and next giving them a bath of logwood, in which they assume a blue colour; which is converted into a violet, either by dipping them in a weaker or stronger solution of alum, or by adding it to the bath, the alum imparts a red shade to the colouring matter of the logwood. This violet possesses but little beauty, or durability; but if the alumed silk be immersed in a bath of Brazil wood, and next in a bath of archil after washing it at the river, a colour is obtained possessing a much higher degree of beauty and intensity. M. Decroizilles' process, above related, for dyeing wool, succeeds equally well, according to his account, in communicating a violet colour to silk.

Of dyeing Cotton and Linen violet.

To communicate a violet colour to cotton and linen, they commonly receive first a blue ground in the vat, proportioned to the shade required, and are then dried. They are afterwards galled with the proportion of three ounces of galls to every pound of stuff, and being left in this bath for 12 or 13 hours, are wrung out and dried again. They are next passed through a decoction of logwood, and when thoroughly soaked and taken out, the bath receives an addition of two drams of alum, and one of dissolved verdigris for every

pound of the yarn. The skeins are then dipped again on the skein sticks, and turned for about 15 minutes, when they are taken out and aired; they are next immersed in the bath for 15 minutes, taken out and wrung. To complete the process, the vat employed is emptied; half of the decoction of logwood not before used is now poured in, with the addition of two drams of alum, and the yarn is again dipped in it till it has acquired the shade proposed, which must always regulate the strength or weakness of the decoction of logwood. This colour bears the air tolerably well, but is much inferior in permanency to that which is obtained by the use of madder.

Of dyeing Wool orange.

Orange being a mixture of yellow and red, may be communicated by the processes for dyeing scarlet in which yellow is used, by diminishing the proportion of red, and increasing that of yellow. Wool dyed red by madder, and afterwards yellow by weld, acquires a cinnamon colour, for which the most proper mordant is a mixture of alum and tartar. The shades may be varied at pleasure by substituting other yellow dye stuffs for weld, and by altering the proportions as circumstances may require. Wool receives a reddish yellow by being passed through the madder bath after having been dyed yellow. Brazil wood is sometimes employed with yellow substances singly, or mixed with cochineal and madder, to produce this colour. When instead of weld, or other yellow dyes, walnut-tree root, walnut-peels, or sumach are used, snuff, chesnut, musk, and other shades are obtained.

Of dyeing Silk orange shades.

Marones, cinnamons, and all the intermediate shades are given to silk, by logwood, Brazil, and fustic, a bath is prepared by mixing decoctions of these three woods made separately; the proportion of each is varied according to the shade required, but that of fustic ought to prevail; the bath should be of a moderate temperature; and the silk, after being scoured and alumed in the usual manner, is immersed in it. The silk is turned on the skein sticks in the bath, and when taken out, if the colour be uniform, it is wrung and dipped in a second bath of the three ingredients, the proportions of which are regulated according to the effect of the first bath, in order to obtain the shade required.

For some colours blue is united to red and yellow, it is thus olives are produced; a blue ground is first given, then the yellow dye, and lastly, a slight maddering. Olive may be dyed without using the blue vat, by dipping the silk in a very strong weld bath, after being first alumed; to this a decoction of logwood is afterwards added, and when the silk is dipped, a little solution of alkali is put in, which turns it green, and gives the silk the olive colour. The silk is repeatedly dipped in this bath until it has acquired the proper shade.

A kind of reddish olive is produced by a bath of fustic to which more or less copperas and logwood have been added. Russet-olive is dyed by adding fustic and logwood to the bath after welding. The addition of logwood alone gives a redder colour, if such is required.

Of dyeing Cotton and Linen orange shades.

By beginning with weld and verdigris, cinnamon colour is given to thread and cotton, which are then dipped in a solution of copperas, wrung, and dried. When dry they are galled with three ounces of galls to the pound dyed; they are then dried again, alumed as for red, and maddered. After being then washed, they are put into very warm soap-suds, and turned until they are sufficiently brightened; a decoction of fustic is sometimes added in the aluming.

M. d'Apligny states that a fine olive may be imparted to cotton and thread from four parts of weld and one of potash, boiled in a sufficient quantity of water, and Brazil wood, which has been steeped one night, boiled separately with a little verdigris; by mixing the two decoctions in the proportions the shade requires, and immersing therein the thread or cotton.

Of dyeing Cloth brown or grey.

To impart a brown shade, the stuff as soon as dyed is dipped in a solution of copperas, to which an astringent has been added; which is better than mixing copperas with the bath, as some do.

Coffee, damascene, and other shades, are produced by giving the cloth first a colour more or less deep, according to the shade wanted, and then dipping it in a bath of galls, sumach, alder-bark, and copperas, according to the effect desired.

Blue-greys are given by solution of indigo in sulphuric acid, combined with a mixture of decoction of galls and copperas. Other shades are obtained by a bath of cochineal,

fustic, and galls, to which copperas is added.

For marone, and similar colours, saunders and galls are employed; and sometimes a browning with the addition of logwood. These colours may be made to incline to crimson or purple, by adding a small quantity of cochineal or madder. A little tartar gives brightness to the colour. With a mixture of galls, fustic, and logwood, some madder, and a little alum, hazel colours are produced.

Of dyeing Silk dark mixed colours.

Silk may be dyed a violet purple, without a blue ground, by preparing it with a mordant of two ounces of alum, one ounce of solution of tin, and half an ounce of muriatic acid, to each pound; steeping it twelve hours in a mixture of one part of galls dissolved in white wine, with three parts of water; and then, after wringing, dyeing it in a bath composed with two ounces of cochineal and a small quantity of iron liquor, till the intended shade is given. Madder may be used in the same way.

Colours resembling that of bricks may be produced, by immersing silk in an annotta bath, after preparing it with a mixture of solution of galls and iron liquor.

By the combination of Brazil, logwood, archil, and galls, and by browning with copperas, a number of different shades are dyed: but though their brightness is pleasing, they are not permanent.

Of dyeing Cotton and Linen dark mixed colours.

Thread and cotton may be dyed a permanent violet, by submitting them, after being scoured in the common mode, to a mordant prepared by boiling two quarts of iron liquor with four quarts of water for every pound, carefully removing all the scum; and adding to this liquor poured into a vat, while warm, four ounces of sulphate of copper, and one ounce of nitre to the quantity stated. In this the skins are steeped ten or twelve hours, wrung out, and dried, and then dyed in a madder bath, if suitable to the shade wanted. If a deep violet is required, two ounces of verdigris must be added to the bath; and the colour becomes still deeper by galling the yarn more or less before it is steeped in the mordant, if the nitre be omitted. If the proportion of nitre is increased, and the sulphate of copper diminished, the violet inclines more to lilac. By modifying the mordant in different ways a number of different shades may be produced.

To dye cotton different shades of marone colour, it is galled, dipped, and worked in the usual way in a bath, to which more or less iron liquor has been added. It is then washed in a bath mixed with verdigris, welded, and dyed in a bath of fustic, to which a solution of alum and soda are sometimes added: it is then completely washed, after that well maddered, then dipped in a weak solution of sulphate of copper, and lastly in soap-suds.

For some hazels and snuff colours, a browning is sometimes given by soot, after the welding, and a madder bath, to which galls and fustic have been added; the soot is sometimes mixed with the bath: a browning is likewise given by solution of copperas. Walnut peels also are used for the same purpose: the colour they impart is rather dull; but it is not liable to be changed by the air into a yellower shade, as is the case in the brownings imparted by means of iron. The goodness of this dye, and its cheapness, are sufficient to recommend its use for grave colours, which are sometimes fashionable.

For calico printing, see CALICO *Printing*.

DYNAMICS. This branch of mechanics relates to the action of forces that give motion to solid bodies; which forces are calculated both by their active powers, and by the proportion of time in which those powers become efficient. Our readers cannot fail to perceive, that the complete analysis of all appertaining to this subject would occupy many formidable volumes; while the generality of those who have absolute occasion to acquire a complete knowledge of dynamics would be led to consult the various elaborate publications that have been published, for the edification of such as possess that disposition. We must, necessarily, study simplicity, so far as our subject may admit, and endeavour to bring the most prominent matters into a moderate compass.

Each body is considered as a mass of atoms divisible *ad infinitum*; the bulk or substance of a mass we consider as having density; which relates directly to the quantity of the matter, and inversely refers to the magnitude. We are also compelled to consider, that, as the generality of bodies are, more or less, porous, their quantity of matter is not in every instance found to correspond with the bulk they exhibit.

Thus, we find, that a pound of gold and a pound of lead, though apparently solid, give very different weights within the same bulk. The former is said to be more dense, while the latter is said to be more rare; density and rarity being opposite qualities. Therefore, if we could always ascertain the number of atoms, or of minute parts, contained in a mass, we should be able to appreciate the density; because, under the certainty that, in proportion as more or less atoms are comprised within a given space, so must the mass be more or less dense; *i. e.* heavier, or lighter.

In computing density we therefore take the rectangle of the mass, and, ascertaining the dimensions, discover by its weight how many atoms, or particles, it contains. Hence is derived our table of specific gravities, or the comparative weights of various bodies of unequal densities. (See Hydrostatics.) From this it will be seen, that bodies of similar substance and form, but differing in bulk, are to each other in proportion to the magnitude of their respective masses; while, on the other hand, bodies of similar form, and equal in bulk, are, to each other, in proportion to their respective densities.

Forces are considered according to the quantities of motion they are capable of producing; but, as we cannot measure those forces, we are under the necessity of ascertaining the power by means of the effect. Thus we can correctly ascertain the force of gunpowder, by the effect produced by the shot; or we can fully explain the force with which the spring of a watch acts, by finding what resistance it is capable of overcoming; or we may compute the strength of a horse, by witnessing the weight he can draw. But it must be obvious, we could not discover *per se*, either the strength of the gunpowder, the elastic powers of the spring, or the muscular vigour of the animal.

Force and velocity are, in fact, synonimous terms; for the impetus given to the shot fired from a cannon, estimated by the bulk of the shot, and the distance to which it may be projected, or the impression it may make on an opposing object, completely supply the result of our research; remarking, that, this being a diminishing force, its action will be strongest at the moment of expulsion, and gradually less as it recedes from the origin of motion, until it finally acquires a state of rest. The spring in a measure partakes of the same diminishing tendency; but as it may be held in equilibrio at any period of its exertion, it cannot be classed with the former, though, rigidly speaking, it is assuredly a diminishing force: for as we see in clocks and watches, springs will in due time arrive at a state of rest, or inaction. The animal power is subject to so many anomalies, that it is next to impossible to treat of it with any strict adherence to calculation; because, in so doing, we are compelled to banish what we know to be the effects of labour, and to consider the power as always equal, and always maintaining the same physical ability. Here, indeed, we find theorists generally proceeding upon a wrong basis; and, of course, rarely correct in their conclusions. We find them estimating the powers of horses, &c. as though their limbs had no flexibility, their muscles no relaxation, and as if their shoulders were insensible to pressure: in fact, they generally consider the animal as a fulcrum of wood, iron, &c. The absurdity of such a calculation must be obvious.

But to proceed. We consider force to be either equal (or permanent), accelerating (or gaining in power), or diminishing (or losing in power). Thus, the motion of a well-regulated clock may be considered as an equal force; because, in equal periods, it proceeds over equal spaces. A weight falling from a height is an accelerating force; because it gradually accumulates velocity in proportion to the space through which it falls; and a shot fired from a cannon is a diminishing force; because it constantly and gradually loses velocity, until, at length, it ceases to move. Dissimilar bodies will move through the same space in exact ratio with their own squares, and their relative impulses; but if two bodies, of equal bulk and density, be set in motion oppositely, by the same momentum, or power, they will hold each other in equilibrio: and if two such bodies so acted upon should meet, they will mutually obstruct each other's progress. Of this we may frequently see instances in the game of billiards. But if two bodies of different density be acted upon by forces that correspond with their masses respectively, the greater will overcome the lesser; as will also a body impelled by a greater force than one of equal density, to which it may come in opposition. Thus, a pistol shot meeting a fives' ball, will cause it to deviate from its course, or to recede.

Uniform, or perfectly equal, motion, does

not exist naturally. It is, perhaps, not to be found any where; though our mechanical arts have furnished us with various instances of great approximation thereto, for a time only. Yet all motions, generally speaking, would be uniform, were it not that obstacles perpetually present themselves to retard their velocity, either perceptibly or imperceptibly. We are, however, compelled to consider uniform motion to exist; else we could form no just comparison on many occasions; and, as some standard is needful, we estimate the velocity of bodies by seconds of time; taking a second as a unit. The following will be sufficient to give a full insight into this part of our subject.

When bodies have different uniform motions, the spaces described are proportional to the times and velocities, jointly. Hence the velocity is as the space divided by the time. For the velocities of two bodies, moving uniformly, are directly as the spaces, and inversely as the time; for, in equal times, the velocities are proportional to the spaces run over; and, if the velocities are equal, the spaces passed over are proportional to the times; again, if the spaces passed over are equal, the velocities are reciprocally as the times.

We have an easy mode of exhibiting the comparative velocities of bodies: let the velocities be described by base lines, and let the altitudes express the time: the area of each figure thus found will display the space over which the body, of which it is respectively the representative, has passed. This shews their progress, whatever may be their direction; but where they follow the same, or a parallel course, though their velocities should be different, their several situations are easily ascertainable. In such case we may consider them as moving in concentric orbits, and after ascertaining their several velocities, remove them, according thereto, at suitable distances from the centre; when all would be found to perform their revolutions within the same period; their velocities being equal to the rectangle contained under the diameters of the orbits in which they severally move. Or, we may consider them all as moving in the same orbit, as the hour, minute, and second hands of a watch, all shew their progress upon the same index, or dial plate.

But we sometimes find two forces acting upon the same body: if they be simultaneous (or equal) the movement of the body being equally acted upon by either, it will assume a medium course, and divide the angle at which the two forces stand apart. Thus, in fig. 1, Plate Dynamics, if a body O be equally impelled by two forces, the one in the direction of S T, the other of N R, it will traverse the diagonal line, O X, and arrive at the opposite corner of the square; and that too in the same time, say one second, as it would have required, if acted upon by only one of the forces, to have passed from O either to T or to R.

If the forces are unequal, the body will be impelled in the same manner towards the opposite point of a parallelogram, and will thus gain more towards the course of the stronger power, than in the direction of the weaker; between which it will exhibit a true proportion. Say, that A B, fig. 2, be the direction of a force three times as powerful as the force A C. The body will move along the diagonal A D, in the same time that it would have been urged by the greater power from A to B; or by the lesser power from A to C. Perhaps no more obvious proof of this could be deduced, than the course of a ship when laying, what is technically called, "near the wind." The real track of the ship is always seen by her wake, or a peculiar mark left in the water; though the ship's head may lay quite in another direction. Therefore, it is customary to ascertain the angle made between the wake and the ship's apparent course, by means of a compass; and to set off that angle under the head of lee-way; the wake always appearing rather towards the weather (or wind-side) quarter of the vessel. Thus, although it should seem the vessel were proceeding in the direct line E F, fig. 3, yet, on account of the wind acting as two different powers, that is partly causing her to proceed in the direction of her keel, and partly in a line with her beam, or diameter, she would arrive at the opposite point G; supposing her progress forward to be twice the amount of her lee-way, or lateral tendency, as above stated, the wake would describe her true course, while her apparent course would always appear to be parallel with the line E F.

Let us suppose that H and I, fig. 4, two equal weights, were to be raised by means of a cord from each meeting in K: the line of force which should raise them with equal velocity, would be along the diagonal K L. If the weights were unequal, the line would not be the diagonal of an equilateral quadrangle, as in the preceding case, but along the parallel Q V of the diagonal formed by a proportionate parallelogram,

fig. 5. The angle being more acute with the line of the greater weight B, and more obtuse with that of the lesser weight C: the parallelogram would be formed of sides corresponding with the proportions of the two weights; which are in this instance considered at 4 to 1.

When various bodies, moving in the same course, are acted upon equally by a second power, not in a line with that of the primary momentum, they will each preserve their relative situations in regard to each other. We have a familiar proof of this in the descent of rain, &c. which will be found to preserve a parallel course among the drops respectively, though they may each be driven from the line of gravity, and be impelled into an oblique direction, by the force of wind. The case is similar among the vessels of a fleet, supposing all to sail alike, when they get into a current: they will preserve their relative situations, and perform all their evolutions, precisely as though they were in stagnant water.

Uniformly varied motion relates to bodies which at regular periods, or at regular distances, receive new impulses, either in the same direction, or in opposition thereto: in the first case the new momentum is to be added to the former velocity: in the latter case it is to be deducted from it. In variable motions we compute the velocity according, either to a medium taken at the average of the accession of forces, or we consider the velocity at the instant chosen for calculation to be equal to an unit; *i. e.* a second of time; we may thus calculate each unit separately. A force causing a body to move quicker, is termed an accelerating force; though the term is also applied to forces which cause the motion to vary: when it occasions a regular encrease of velocity, by an equable addition of impulse, it is termed an uniformly accelerating force; but if it occasions a body to move regularly slower, as an additional weight in mechanics, or a lengthened pendulum in clock-work, it is called an uniformly retarding force.

A single body would, by a constant force, give four objects of consideration, *viz.* the space, the time, the velocity, and the force: any three of these being given, the fourth may be found. For, the velocities generated in equal bodies, by the action of constant forces, are in the compound ratio of the forces and the times of acting. The momenta generated in unequal bodies are also conjointly as the forces, and their times of action; and the momenta lost or destroyed in any times, are likewise conjointly as the retarding forces, and their times of action: for an equal opposing force would, in equal time, destroy the impelling force. The velocities generated or destroyed in any times, are directly as the forces, and times; and reciprocally as the bodies, or masses. In all motions uniformly accelerated, when the force and body are given, the space described during a certain time, is the half of that which the body, moving uniformly with the last acquired velocity, would describe in an equal time; and the spaces described by a body uniformly accelerated, are as the squares of the times; hence the velocities acquired being as the times, we shall find the spaces described to be the squares of the velocities. Therefore either the velocities, or the times, are as the square roots of the whole of the described spaces. And this applies equally to motions uniformly retarded.

Of variable motions in general. By this we immediately refer to those forces which act incessantly, but always in different degrees of strength: of this we have an instance in the release of springs from heavy pressure; whence they gradually recover the form in which they were made. A carriage set in motion, though the horses may appear to act uniformly, nevertheless occasions less exertion to them, when it has acquired its due degree of velocity. For bodies in a state of rest, are, in a manner, disposed to remain so; and bodies in motion, are disposed, in a certain degree, to continue so, as will be subsequently shewn: therefore, we find the first effort to be considerable; while, on the other hand, it often requires much resistance on the part of the horses, even on level ground, to discontinue that motion of which their forces were the cause. Besides this illustration, we find that bodies are very sensibly affected by the forms of those spaces over which they have to pass: admitting the ascents to be equal, and the whole to be perfectly level, and free from impediments; which, indeed, must ever be understood, while treating of the motion of bodies, especially by comparison. If a body X should have to pass over the point A, fig. 6, along the plane A B, its motion would be uniformly continued by the power C; but if the surface were concave as A D B, then the first part of the motion would be more rapid than the latter; because the commencement of the concave space being

more horizontal than the latter, or upper part, would permit the force to act more powerfully on the body D. On the other hand, if the line of ascent were convex, as at A E B, the first part of the ascent being steepest, would be slowest; and the latter, in consequence of its regular approach to the horizontal, would be proportionately rapid. Thus we see, that C is an uniform force on the plane A B; an accelerating force on the convex ascent A E B; and a retarding force on the concave ascent A D B: we therefore deduce, that accelerating and retarding motions may be described by arcs of which the axes are easily ascertained.

There is a kind of fluctuating, or alternate force to be found in the action of forcing pumps. In these the compression of the fluid, and of the intermediate air, demands a greater force, in proportion as the piston descends: and *vice versa*, as it ascends; the gradual increase of compression, furnished by the return of the fluid into the lower part of the cylinder, causes a gradual diminution of resistance to the upward motion, and consequently acts as an accelerating force.

When bodies at rest fall from heights, the times employed are, respectively, as the square roots of the cubes of the heights from which those bodies fall. We may, perhaps, form a ready estimate of this circumstance when we recollect that gravity gives to all falling bodies an accelerating force. In the latitude of London, a heavy body falls nearly $16\frac{1}{12}$ feet in the first second; which velocity is not only doubled in the next second, so as to amount to $32\frac{1}{2}$ feet, but quadrupled by means of the additional force gained by the continued action of gravity; the third second of time will give $96\frac{1}{2}$ for its increase, and the fourth second will give $128\frac{2}{3}$. In this we suppose the bodies not to be impelled downwards by any force, (exclusive of gravity) but to be in a state of rest, and allowed to descend simply by their own weight; for instance, by cutting the line that suspends a weight.

As bodies gain velocity in falling, so they lose velocity when projected upwards. If a body be impelled upwards, with the same force it had acquired in falling, its velocity upwards would gradually decrease in the exact ratio that it increased in descending, and with such a power it would reach to that height whence it had fallen, but no further. Hence, by ascertaining either the time of ascent, or of descent, the height will be discovered. It is worthy of notice that the acquired velocities are as follow: 2, 4, 6, 8, 10, &c. upon each preceding second respectively; the spaces for each time being 1, 3, 5, 7, &c. respectively, and their constant differences 2. These laws of acceleration were ascertained, by Galileo, to prevail equally in the motion of bodies along inclined planes, which may indeed, be fully proved by observing the progress of a ball as it descends a hill: but this will not hold good unless the body be at perfect liberty; for in cases of interruption, each gradation must be considered as the incipient motion; were it otherwise, no carriage could descend a long declivity, without the certainty of being dashed to pieces, nor ascend a hill at the same pace throughout.

The force which accelerates, or retards, the motion of a body upon an inclined plane, is to the force of gravity, as the height of the plane to its length; or as the sine of the planes elevation to the radius; and if the diameter of a circle be perpendicular to the horizon, and chords be drawn from either extremity, the time of descent down all the chords will be equal; and each will be equal to the time of free descent through the vertical diameter. In the circle, fig. 7, the line A B is a vertical diameter, the chords A C, A D, A E, and E B, are all of different lengths, and of different inclinations from the horizon. It is evident that, in every instance, the shortest chords have the least deviation from the horizontal; consequently they must retard the progress of a body passing down them, much more than those which approach to the vertical; the latter, obviously, give a more free passage to the body; and as they become more vertical, approach nearer to the free descent at A B.

When a body descends along any number of contiguous planes, it will ultimately acquire the same velocity as would have been acquired by falling perpendicularly through the height of the whole number of planes. The times of descents along similar arcs, similarly situated, are as the square roots of those arcs; or as the square roots of the radii of their respective circles. And if a body, being at rest, is suffered to fall down a curved surface, which is perfectly smooth, the velocity acquired will be equal to that which would result from falling the same perpendicular height. It will require an incipient force to urge the body back, to the height whence it fell,

equal to that which it had acquired on reaching the bottom of the curve. Therefore a body falling from O, fig. 8, to the bottom P of the curve O P S, would have power to reascend (excluding friction) to S, which is level with O; and it would rise from P to S in the same space of time it occupied in falling from O to P; in either case the time occupied would be the same as from X to P. When treating of the pendulum this will be more obviously demonstrated.

It was for a long time supposed that a body would move more rapidly in a direct line, not being vertical, than by any other course; but it has been ascertained that any curve, not exceeding 60 degrees, is a quicker descent than its chord; and that a curve of 90 degrees is a quicker descent than any tangent laying between the same parallels. Thus, in fig. 9, the curve A B C is of quicker descent than the chord A C, and the curve M A B C gives a quicker descent than the tangent F G, or H I, or K L, laying between the same parallels M K, and C D.

With regard to the motions of projectiles, we refer the reader to that article.

Of central forces we have already given an article, but shall observe here, in addition, that all bodies, when put in motion, would preserve their respective velocities, and their original directions, were they not acted upon by other forces. When a force acts equally for a limited distance, and then is superseded by the actions of another force, the body will describe a polygon in its track; but if the original force be gradually weakened, the body will then describe a curve, bending towards the centre of attraction, resulting from the operation of a deflecting force, which, by its pressure, causes the body to bend from its original direction. When a body is constantly attracted towards a centre, it is under the influence of a centripetal force; and when it is disposed to fly from that centre, it is under the bias of a centrifugal force. These two latter constitute what are termed central forces. The projectile force is the original direction of an impelled body, forming a tangent with the curve occasioned by the deflecting force. The track of a body under the influence of a centripetal force, is called its trajectory, or orbit. The radius vector is a line drawn from the centre to which the force is referred, or wherein it is supposed to act, to any point in the trajectory where the body is found. A body moving regularly on a trajectory, or orbit, which returns into itself, is, on its return to the incipient point whence the motion began, said to have made a period; and the time occupied is called its periodical time. It must be understood, that a body can neither set itself in motion, nor avert its own course; such effects must be the result of forces exteriorly applied; also we must state, that the motion of each body is naturally in a right line, but by the impulse of some one or more powers, its course will deviate into a curve. Thus a pebble in a sling, or a full glass of water, placed within a hoop that is turned swiftly round, will follow the course of the sling or hoop, respectively; but when liberated, or improperly checked, they will fly off in a right line, which they must preserve, if not opposed by the air, &c.

We invariably find, that, when a boat is pushed off from the shore, a certain bias towards the place quitted is felt by every person on board. If any thing should be overset at that instant, unless pressed towards any other point, it will fall towards that shore. On arriving at the opposite bank, if the boat is allowed to run against it, a disposition to fall towards that bank will be manifested by every person, and by every matter, at liberty, within the boat. Hence we find, that all bodies at rest are disposed to remain so; and that, when bodies are set in motion, they would continue to move, were they not obstructed by either a mechanical, or an invisible, agent. All bodies moving in orbits have a disposition to fly out of them; and those which describe orbits of the smallest diameter have rotatory motions quicker than those which take a greater range. If one body moves round another, both will describe curves round their common centre of gravity. The centrifugal force of a revolving body is in direct proportion to the quantity of matter, multiplied into the velocity. The centripetal forces in circles are as the squares of the velocities directly, and of the radii inversely: therefore when the centripetal force, and the distance from the centre are given, the velocity is given. The mutual attraction of bodies does not affect their centre of gravity: and if, while two bodies act on each other, they be projected in opposite and parallel directions, with velocities in proportion to their respective distances from the centre of gravity, they will describe similar figures around that centre. It

is on these principles (which involve an immense collection of cases, and circumstances), that the science of astronomy, and whatever relates to the wonderful correspondence we observe in all the operations of the grand universal system, is founded.

In rotatory motions we are always to consider, that every atom which is at rest requires a certain power to cause its removal; and, that when one part of a wheel moves, the whole must move; therefore the power must be such as is equal to move the whole. Hence we find, that in a well-balanced wheel the motion is easy, because there are as many atoms disposed to descend as there are to be raised; consequently, the opposing atoms are held in equilibrio. We must observe, however, that the resistance to motion is greater as we approach the centre; for a power which would give a wheel motion when applied at its perimeter, or exterior, would be inadequate to set it in action if applied near to the axis. Therefore powers applied at the greatest distance from the centre, have more force than such as are applied nearer to the centre: their effects will be in exact ratio with the squares of their distances from the centre, while the imparted velocity will diminish in exact proportion with the accession of force. Of this we see innumerable instances in clocks, cranes, and other machines, in which one wheel is made to move another; or in any system of wheels. We cannot, indeed, have a more familiar demonstration than is afforded by the greater facility with which the hind wheel of a coach revolves, compared with the fore wheel, which, being so much smaller, has the power (*i. e.* the earth) so much nearer its axis, and consequently revolves with an increase of velocity proportioned to its difference of diameter.

Before we quit this article it may be proper to observe, that the principles of gyration and of oscillation have a close connection with the foregoing points. The powers of windlasses, winches or cranes, jacks, &c. all depending upon the application of a power at more, or less, distance from the centre. Thus we find the common steelyard is affected by the removal of the pea, or shifting resistance, along a scale, whereon the power is indicated to augment, according as it recedes from the point of oscillation. But we see that in scales equally removed from that centre, the perpendicular distances of the weight, or of the goods to be weighed, do not in any degree change the power, when the two points of suspension are equidistant from the centre of oscillation; and that the two scales, together with their suspending cords, &c. are perfectly counterbalanced. A reference to fig. 10. will exhibit that, provided the two arms, or suspending points, A A, be equally removed from the point of oscillation, C, it matters not whether the scales be at equal distances below A A respectively, or whether one scale be at D and the other at E, provided all their respective parts be perfectly equipoised; but if one arm should be longer, so as remove one scale further from the centre of oscillation, by giving unequal distances, C A and C F, between the two parts of suspension, their state of equilibrium would be thereby totally destroyed.

We shall now finally observe, that in every branch of mechanics it will be found, that equable motion is the surest, the safest, and the most durable; and that, in proportion as the forces, and the resistances thereto, are broken or fluctuating, so will the former be diminished and the latter be increased. Hence experience shews us, that windmills wear more than water-mills, and that animal powers are apt to tear machinery to pieces. We can command an uniform supply of force where water is the power; but hitherto no means have been found so completely to regulate either the quantity of wind, or the paces of cattle.

DYNASTY, among ancient historians, signifies a race or succession of kings of the same line or family: such were the dynasties of Egypt. The Egyptians reckon thirty dynasties within the space of 36525 years; but the generality of chronologers look upon them as fabulous. And it is very certain that these dynasties are not continually successive, but collateral.

DYSENTERY. See MEDICINE.

DYSOREXY, among physicians, denotes a want of appetite, proceeding from a weakly stomach.

DYSPEPSY, a difficulty of digestion, for which physicians prescribe bitters.

DYSPNOEA, a difficulty of breathing, usually called asthma.

DYSURY, in medicine, a difficulty of making urine, attended with a sensation of heat and pain. It is distinguished from a stranguary, as in the last, the urine is voided by only a drop, as it were, at a time, but, however, with pain; and from an ischury, as in this disorder, there is an almost total suppression of urine.

DYTISCUS, in natural history, a genus

DYNAMICS.

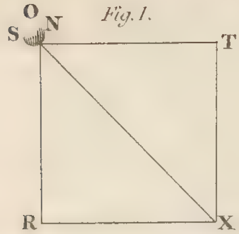


Fig. 1.

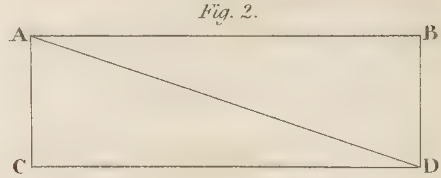


Fig. 2.

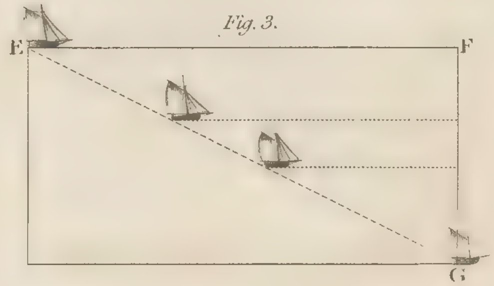
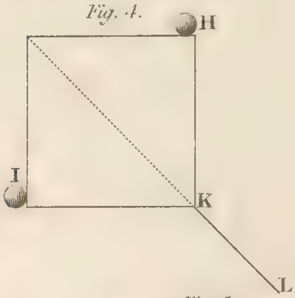


Fig. 3.



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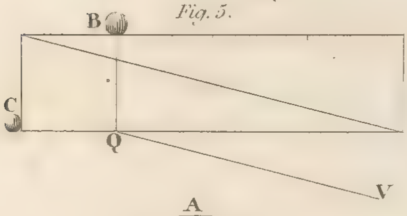
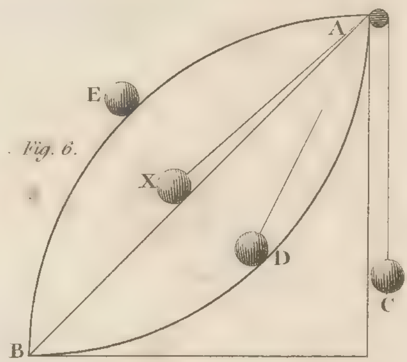


Fig. 5.



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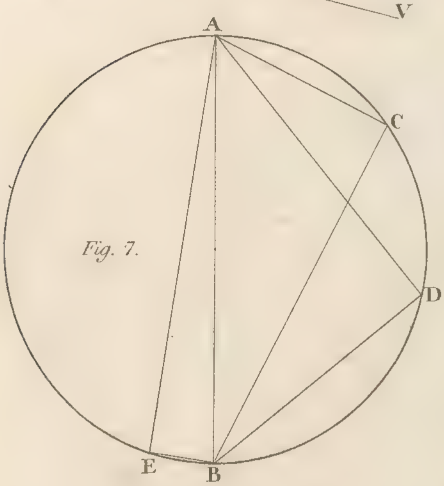

Fig. 7.

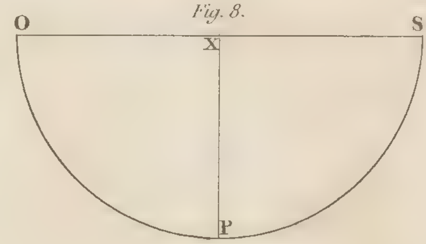

Fig. 8.

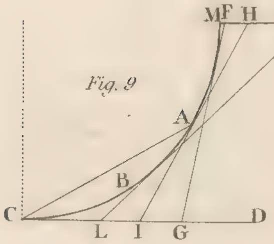

Fig. 9

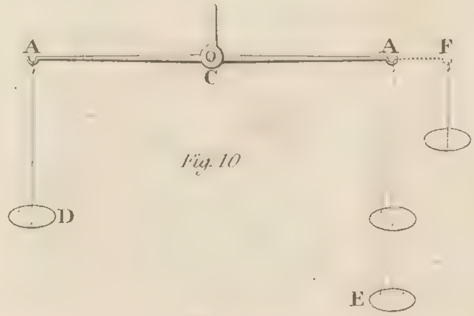

Fig. 10

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of insects of the order Coleoptera. Antennæ setaceous; feelers six, filiform; hind-legs formed for swimming, fringed on the inner side, and nearly unarmed with claws. Nearly two hundred species of this genus have been enumerated. This has sometimes obtained the English name of water-beetle, it being an aquatic genus, and rarely seen in flight except during the evening. One of the largest European species is the D. marginalis, about an inch long, of a ochre colour: the whole insect is of a polished surface on the upper part, and the wing-shells are each marked by two rows of scarcely perceptible impressed points. This insect is not uncommon in stagnant waters, where its larva also resides, which is of a very extraordinary shape, and so unlike the animal into which it is at length transformed, that no one, not conversant in entomology, would suppose it to have the most distant relationship to it. It is of a bold and ferocious disposition, committing great ravages, not only among the weaker kind of water-insects, as well as water-newts, tadpoles, &c.; but even among fishes, of which it frequently destroys great numbers in a season, and is therefore justly considered as one of the most mischievous animals that can infest a fish-pond. A larva of this kind has been known to seize on a young tench of three inches in length, and to kill it in a minute. When arrived at its full growth the larva betakes itself to the banks of the water it inhabits, and forming an oval hollow in the soft earth or clay, in a few days changes into a chrysalis much resembling that of the genus scarabæus, and of a whitish colour. From this, in the space of about three weeks, proceeds the complete insect. Many other much smaller species of this genus may be found in ponds. There have been enumerated forty-nine species of British dytisci.

E.

E, The fifth letter of the alphabet, and second vowel, has different pronunciations in most languages. The Greeks have their eta η, and epsilon ε, or long and short *e*. The French have their *e* open pronounced much like our *a* in the words *face* and *make;* their *e* masculine, pronounced not unlike our *y* at the end of words, as *liberté, liberty;* their *e* feminine, or mute, very weakly if at all pronounced, added generally at the end of words, either to distinguish the feminine gender, or lengthen the syllable; and their *e* before an *m* or *n*, which sounds like our *a* in the word *war:* these are all exemplified in the words *empechée* or *enfermée.* In English there are three kinds of *e, viz.* the open or long *e*, as in the words *bear, wear;* the close or short *e*, as in *wet, kept;* and mute *e*, which serves to lengthen the syllable, as in *love, came,* &c.

As a numeral, E stands for 250. In music it denotes the tone *e-la-mi.* In the calendar it is the fifth of the dominical letters. And in sea-charts it distinguishes all the easterly points; thus, E. alone denotes east, E. by S. and E. by N. east by south, and east by north.

EAGLE. See FALCO.

EAGLE, in astronomy. See AQUILA.

EAGLE, in heraldry, is accounted one of the most noble bearings. They are generally borne with their wings and tails expanded. This posture is best fitted to fill up the escutcheon.

EALDERMAN. See EARL.

EAR. See ANATOMY and COMPARATIVE *anatomy.*

EAR, in music, implies, that sensible, clear, and true perception of musical sounds by which we are offended at dissonance, and pleased with harmony. To have an ear, which is a common phrase, is to be capable of distinguishing the true intonation from the false, to be sensible of metrical precision, and to feel all the nicer changes of artificial combination.

EAR *pick*, an instrument of ivory, silver, or other metal, somewhat in form of a probe, for cleaning the ear.

EAR *wax.* See CERUMEN.

EAR *wig.* See FORFICULA.

EARING, in the sea-language, is that part of the bolt-rope which at the four cor-

ners of the sail is left open, in the shape of a ring. The two uppermost parts are put over the ends of the yard arms, and so the sail is made fast to the yard; and into the lowermost earings, the sheets and tacks are seized or bent at the clew.

Earl, a British title of nobility, next below a marquis, and above a viscount. Earls were anciently called *comites*, because they were wont *comitari regem*, to wait upon the King for council and advice. The Germans call them *graves*, as landgrave, margrave, palsgrave, rheingrave; the Saxons ealdermen, unless that title might be more properly applied to our dukes; the Danes, eorlas; and the English, earls. The title, originally, died with the man. William the Conqueror first made it hereditary, giving it in fee to his nobles, and allotting them for the support of their state the third penny out of the sheriff's court, issuing out of all pleas of the shire whence they had their title. But now the matter is quite otherwise; for whereas heretofore *comes* and *comitatus* were correlatives, and there was no comes or earl, but had a county or shire for his earldom, of latter years the number of earls increasing, and no more counties being left, divers have made choice of some eminent part of a county, as Lindsey, Holland, Cleveland, &c.; some of a lesser part, as Strafford, &c.; others have chosen for their title some eminent town, as Marlborough, Exeter, Bristol, &c.; and some have taken for their title the name of a small village; their own seat or park, as Godolphin, Clarendon, &c. An earl is created by cincture of sword, mantle of state put upon him by the King himself, a cap and a coronet put upon his head, and a charter in his hand. All the earls of England were formerly denominated from some shire, town, or place, except three; two of whom, *viz.* Earl Rivers, and Earl Paulet, take their denomination from illustrious families; the third is not only honorary, as all the rest, but also officiary, as the Earl Marshal of England.

Earl *Marshal of England*, is a great officer who had anciently several courts under his jurisdiction, as the court of chivalry, and the court of honour. Under him is also the herald's office or college of arms. He hath some pre-eminence in the court of Marshalsea, where he may sit in judgment against those who offend within the verge of the King's court. This office is of great antiquity in England, and anciently of greater power than now; and has been for several ages hereditary in the most noble family of Howard.

EARNEST, a part of the price paid in advance to bind parties to the performance of a verbal agreement. The party is then obliged to abide by his bargain, and is not discharged upon forfeiting his earnest, but may be sued for the whole money stipulated, and damages; and by the statute of frauds 29, c. 2. c. 3, no contract for sale of goods not to be delivered immediately to the value of 10*l.* or more, is valid, unless contract is made by the parties, or those lawfully authorized by them, or earnest is given.

EARTH, the vast mass or planet we inhabit. The scientific and theoretical attempts which have been made to ascertain the form and internal composition of the earth have produced less certain results than could be wished. With respect to the grand outline, we may conclude, without much danger of error, that it is spherical; which observation is supported by the appearance of the moon, the nearest body to the earth. We may illustrate this supposition by drawing a true circle, and filling its circumference with a capricious outline, sometimes touching and at others receding from it. The cause of the inequalities, which we denominate mountains and vallies seems to be the natural consequences of the composition of the earth, the action of the air and water ever changing the position of the softer materials, and having but little effect on the hardest. Thus, on the borders of the sea large tracts of land are known to crumble into it, and that even mountains are undermined: Mont Blanc has recently afforded a most melancholy proof. Besides the above causes, there are others volcanic, and arising from the earthquakes produced by them. Still greater changes in the surface of the earth have taken place at periods beyond the records of history, except in the single instance of the scriptures and the Deluge, which is demonstrated by the discovery of substances evidently peculiar to the sea only, in the highest mountains, where it is impossible to account for their arrival, but by supposing that the spots where they are found were raised by strong internal pressure from the centre under the bottom of the sea, which doubtlessly presents a surface very similar to the parts we inhabit.

Before the invention of instruments cal-

culated to ascertain geographical doubts with precision, and the circumnavigation of the globe, the ancients imagined the earth flat or cylindrical; but the moderns, with greater truth, derived from superior means, pronounce it almost spherical, founding their opinion upon the following just grounds: the circular shadow of the earth in eclipses of the moon, the general appearance of the planetary system in all parts of the earth being the same, and the observations made in circumnavigating it concurring with those which must result from a globular form. That great philosopher, Sir Isaac Newton, was led by accident to suppose, from the revolving of the earth round its axis, and the laws of hydrostatics, that it is an oblate spheroid, flattened at the poles. Professor Jameson admits the truth of this supposition, and says, "The spheroidal figure of the earth is a proof of its original fluidity. This important conclusion was never disputed; the only question has been, whether this fluidity was the effect of fire or water. Rocks, which have been formed or altered by the action of heat, are most distinctly different from those that constitute the great mass of the crust of the globe; consequently, this fluidity cannot be attributed to the agency of heat." Whether the conjectures on the opposite hypothesis are founded on a tenable basis, cannot be ascertained to demonstration; but it may not be amiss to let the Professor speak further on the subject. "The only other agent we are acquainted with that is capable of producing this fluidity, is water; and we have the strongest evidence that it has been the active agent. In chap. 2, when mentioning the effects of water on the surface of the globe, we described several mechanical and chemical depositions which are daily taking place, as it were, under the eye; and we may now add, that a comparison of their structure, with that of the great fossil masses of which the crust of the earth is composed, evinces so complete an agreement, as entitles us to infer with great certainty, that these also have been formed by the same agent. As the highest mountains are composed of rocks, possessing a structure resembling those fossils which have been formed by water, we naturally conclude, that the ocean must have formerly stood very high over these mountains. Further, as the most elevated mountains are composed of rocks, such as granite, gneiss, mica-slate, clay-slate, and others, which extend around the whole globe, and have been formed during the same period of time; it follows irresistably, that the ocean must have formerly covered the whole earth at the same time."

In order to clear the surface of the earth of this superabundance of water, which militates against the existence of life but in one species of the animated system, and equally against every species of vegetation, our theorist observes, "It was reserved for Werner to give this theory stability. With his usual acuteness, he soon discovered that the important documents for the illustration of this great phenomenon, were not to be sought for in the formations that have taken place within the limits of human history, but in the mountains themselves, those mighty aquatic formations. His investigations were attended with complete success; for he discovered, 1st, That the outgoings of the newer strata are generally lower than the outgoings of the older, from granite downwards to the alluvial depositions, and this not in particular spots, but around the whole globe. 2nd, That the primitive part of the earth is entirely composed of chemical precipitations, and that mechanical depositions do not appear until a later period, that is, in the transition class; and that from this point they continue increasing, through all the succeeding classes of rocks, to the newest, or the alluvial, which are almost entirely mechanical deposits. These most important observations ascertain, in a satisfactory manner, the universal diminution of the water from the surface of the earth."

To obviate the difficulty above noticed, the Professor supposes animals to have been created as the earth was cleared to receive them; but the superfluous water is still in want of a receptacle capacious enough to contain it: such are the unfortunate consequences of theory. Newton has certainly proceeded upon the best data, and his calculations are almost universally correct and convincing.

When M. Richer visited Cayenne, he found a clock, he then possessed of particular excellence, which had gone perfectly true at Paris, lost daily two minutes and twenty-eight seconds; the situation of the island is about five degrees from the equator, and although the heat of a climate lengthens pendulums, and impedes their motion, yet that of Cayenne was by no means sufficient to produce so considerable a difference, which cannot otherwise be accounted for

than by admitting less pressure of gravity to have caused it. In the revolution of the earth, its parts recede from the axis, and the equatorial particularly, consequently the polar press internally, and raise the former, till an equilibrium occurs; hence the form of an oblate spheroid, the shorter axis of which passes through the poles. Pursuing the lights afforded him by nature in a superior degree, Newton calculated the different diameters, and found that the equatorial exceeds the polar 34 miles and one-fifth. This assertion was combated by several philosophers on the continent, but it was fully confirmed subsequently by the admeasurements and observations of two deputations of mathematicians who visited the vicinity of the northern and southern poles in 1735, and agreed in pronouncing them flattened, making the difference between the diameters as 266 to 265, or as 179 to 178.Many calculations of profound subtlety have since been made, but as most of the calculators contradict each other, too much reliance ought not to be placed on either; those may be found in various publications, and particularly in the Philosophical Transactions, to which brevity compel us to refer the very curious reader.

The magnitude of the earth is subject to the same uncertainty as the exact figure of it; but repeated endeavours have been made to ascertain it with some degree of precision. According to Diogenes Laertius, Anaximander was the first who attempted this difficult task; it may be supposed with no great success, as he lived 550 years before the Christian æra, though his result was adopted till the period when Erastosthenes flourished. Aristotle, in speaking of this subject says, mathematicians make the circuit of the earth 40,000 stadia, probably including the measurement of Anaximander. Certain Arabian philosophers, by the command of their monarch Almaimon, afterwards proceeded to the plains of Mesopotamia, where they went through the process then best known, and found that the circumference of the globe was from 20,160 to 20,340 miles.

Professor Snell, of Leyden, measured considerable distances between the parallels about 1620, and thus found one degree amounted to 19 Dutch miles, and the whole circumference to 6,840 miles.

Richard Norwood measured the space between London and York with a chain, fifteen years afterwards, and on the 11th of June, 1635, old style, he took the sun's altitude at the meridian, with a sextant of five feet radius, and found a degree of 69 miles, one half, and 14 poles, whence he inferred that the diameter of the earth is about 7,966 miles, and the circuit 25,036 miles. This measurement, though far superior to those of the ancients, was tried by several French mathematicians, who suspected some slight errors, by the King's command, with a quadrant of $3\frac{1}{6}$ feet radius, French measure, when they ascertained a degree consisted of 542,360 feet. M. Cassini, jun. acting under the same authority, used a quadrant of 10 feet radius, in 1700, with which he obtained the latitude, and one of $3\frac{1}{3}$ feet for taking the angles of the triangles, by which experiment he found the degree to be nearly $69\frac{1}{2}$ English miles.

From these and other attempts of a similar nature, to obtain the length of one degree of the meridian which is to be multiplied by 360, the following mean is generally adopted.

The earth's circumference, 25,000 miles.
The diameter, $7,957\frac{3}{4}$.
The superficies, 198,944,206 square miles.
The solidity, 26,393,000,000 cubic miles.

It is conjectured, besides from the measurement of the most approved maps, that the unexplored portions of the earth and seas contain 160,522,026 square miles, the inhabited part of the former 38,922,180, thus divided, Europe 4,456,065, Asia 10,768,823, Africa 9,654,807, and America 14,110,874.

The attentive and skilful observer of the works of nature, whether when employed in examining the most wretched or the most sublime, will find that judgment and infinite wisdom and ingenuity has equally prevailed throughout. Can it then be supposed for a moment, that the internal parts of the earth we inhabit, has received less attention from the Creator, than those objects which are under our immediate and unimpeded inspection? Were it possible to entertain a thought so erroneous, we possess strong proofs to the contrary, which convince us that order and regularity reign beneath us in the same degree as around us. Before the industry, or, more properly speaking, the avarice of man, had led him to penetrate as far as his limited powers will permit towards the centre, he had but few opportunities of ascertaining, and that only from analogy, how the different strata of the earth was disposed, and connected or held together by the vast masses of stone, which may be called the bones of this vast

body. As scientific men were gradually admitted to the knowledge of the secrets of the earth, by the exertions of the miner, in the same proportion did all ideas of a chaos vanish, and we are now convinced, though their excavations are mere punctures in the globe, that were it possible to penetrate through, it would tend to prove that self-existing causes, originating immediately from the Creator, are constantly employed in preserving the whole from derangement, and what we term decay, which, in truth, is simply a change of form, and not annihilation. The celebrated miner, Agricola, was the first who recorded the internal properties of the earth, between whose time and that of Werner, some discoveries were made as to its structure; Lehman formed the idea of primitive and secondary classes of mountains. Cronstadt conjectured the age of several mineral repositories. Hamilton, Dolomieu, and Spallanzani have gone to very successful and satisfactory lengths in ascertaining the operations of volcanos. The nature of the materials which support them, and the substances they eject, Saussure has increased our knowledge of rocks, Williams of the independent formation of coal, and Werner has profited by every preceding observation, and possessing a cultivated genius of his own, united them into a system which approaches nearer to the truth than the nature of the subject would lead us to suspect. Unfortunately the labour and expense of penetrating to any great depth into the earth, ever has and ever must limit our knowledge of the extent of strata, and its similarity in different latitudes, but from the opportunities already afforded by mines, we are led to conclude that those lines of matter spread through vast spaces, if not throughout the globe; many theories have been attempted to account for their varieties and capricious elevations and depressions from a horizontal direction. Dr. Woodward, who deeply considered the subject, supposes all the terrestrial masses disposed in strata to have been dissolved by the waters of the deluge, which subsiding the most pondrous, fell to the bottom, and the rest settled in gradations suited to their specific weights. This solution naturally disposes the strata uniformly horizontal, and he accounts for the breaks in the lines and fissures every where observable by the action of volcanos, earthquakes, &c. &c. Buffon's fancies of corners torn from the sun by comets, and the earth lignified by fire, barely deserve notice, and make a disgraceful contrast with Woodward's ingenious conjectures. The surface of the earth is known by every enlightened person to be composed of a confused mass of vegetable, and in some slight degree of animal substances, below which Jameson says There are four different kinds of structure: — "The first is that which is to be observed in hand specimens; it is the smallest kind of structure, and occurs in what are termed mountain-rocks or stones. The second kind of structure, or that of mountain-masses, is more on the great scale, and is not to be observed in hand specimens, but only in single masses of rock. To this structure belongs stratification, and the seams of distinct coucretions. The third kind of structure is that of rock formations, or those great masses of which the crust of the earth is composed. To examine this kind of structure, we must traverse considerable tracts of country. The fourth kind of structure is that of the earth itself, which is formed by the junction of various formations. To examine this structure we must travel through many countries."

When in passing through long tracts of land we observe loose rocks, firm rocks, clay, sand, &c. &c. in succession, in those instances the strata of the earth lay almost perpendicular, in large masses of rocks, which present nearly a plain front, the inclination of the strata is distinctly visible, and in some cases their agreement with others opposed to them demonstrate that they have been separated by some convulsion of the earth.

The gravity of a portion of the earth was calculated by Dr. Maskelyne in the years 1774 and 1775, at the mountain Schehallien, and its attraction on a plummet ascertained on each side; besides which, he computed the quantity of matter contained in it by a considerable number of sections in various directions; and the result being afterwards compared with the acknowledged magnitude and attraction of the earth, he found that the density was as 9 to 5 of common stone, and as 9 to 2 water; whence it was inferred that large quantities of metal lay concealed within it. Before this period little was known of the gravity or density of the earth, though the relative densities of that and others of the planets had been ascertained with tolerable precision. From the data thus acquired, the quantity of matter in the earth is known to be equal to the product of its density by its magnitude; the force

of attraction on the surface has been proved by experiments, that substances fall $16\frac{1}{12}$ feet in one second of time; and hence that if any place within or beyond it may be known, as in the former case the force is at its distance from the centre, and in the latter as the square of its distance from the same point.

The earth has three motions: that which gradually occasions the precession of the equinoxes; that round its axis, which causes the succession of day and night, accomplished in 24 hours; and that of the whole mass round the sun in a wide orbit, of which the luminary of day is the centre: in the latter its axis is constantly parallel to itself, and inclined in the same angle to its path; thus producing the visible and perceptible alteration from spring to summer, and from that period to winter. This annual motion of the earth round the sun is performed between the orbits of Venus and Mars, with the former and that of Mercury within its own, or between it and the sun in the centre, and those of Mars, Jupiter, Saturn, &c. above it or without, which are called from this circumstance superior planets, and the rest inferior. The time occupied in performing this revolution is 365 days, 6 hours, and 49 minutes, or a tropical year, calculated from an equinox or solstice to the same again; the sidereal year, as computed from any fixed star to the same point, and seen from the sun, makes the revolving of the earth to occupy 365 days, 6 hours, and 9 minutes: the figure of the orbit is elliptical with the sun in one focus; the supposed distance is 95 millions of miles, admitting the sun's parallax to be $8\frac{2}{3}''$, or the angle beneath which the semidiameter of the earth would appear from the sun; "and the eccentricity of the orbit, or distance of the sun in the focus from the centre of this elliptic orbit, is about $\frac{1}{60}$th of the mean distance."

There are nine descriptions of earth, which are barytes, strontian, lime, magnesia, alumina, yttria, glucina, zirconia, and silica. Every substance is an earth which is insoluble in water, or becomes so when combined with carbonic acid, with little taste or scent under the above circumstances, and incapable of alteration by fire when in a pure state, then capable of being turned to white powder, and not exceeding 4.9 in specific gravity.

The word earth is generally applied to the whole mass of the globe, and always to the mould which supports the growth of vegetables; the latter has been attentively examined by various chemists, and found to consist of several substances, without any regularity in their arrangement.

EARTHQUAKE. The dreadful consequences attending sudden and violent tremblings of the earth are sufficient reasons for attempting to account for their causes, but as from the nature of those it is utterly impossible to ascertain them accurately, rational conjecture must be accepted in place of actual observation. Every writer on the effects of volcanic eruptions concur in attributing earthquakes to their internal operations, which become less frequent in their neighbourhood after violent explosions through the craters; indeed it must be obvious on the first thought, that the furious efforts of fire, hot air, and steam, exclusive of electric matter cannot but produce convulsive motion in the substances which confine them, and of more or less extent and violence in proportion to the cause. When a free passage is obtained, the agitation gradually subsides, and is only increased at intervals by the escape of accumulated matter. Sir William Hamilton, who carefully examined all the visible phenomena produced by the earthquakes of 1783, in Calabria, is decidedly of opinion, that they originated from under the sea, situated between the coast of Calabria and the Island of Stromboli, or near the city of Oppida, which he illustrates by forming a circle round those points, and remarking that the most destructive effects were there, whence they became gradually less ruinous. Mount Stromboli had been unusually quiet for some time previous to this calamitous period, a circumstance highly favourable to his conjecture, founded besides on the experience of remote ages, when, according to Strabo, Campania was subject to frequent and dreadful earthquakes, which were less common and ruinous after Vesuvius had become the means of dispersing the confined matter. Since that fortunate æra, the vicinity of the above mountain has suffered more from the lava and ashes than earthquakes.

If stronger proofs were necessary, that volcanic operations cause this phenomenon, the rising of hills near Ætna, or any other volcano, and the Lipari Islands, are sufficient demonstrations how severely the earth must be convulsed by subterraneous fires; those consequences are not, however, always visible, earthquakes often occurring without any other effect than the overturn-

ing of slightly built edifices, an undulating or shaking motion, and a deadened sound; but it by no means follows that the origin of such were not to be attributed to fire, the vapours caused by which may roll through cavities, actually pass from a very great distance to a volcanic mountain, or escape unperceived through the sea or obscure vents.

The electric fluid being known to reside in the earth in very considerable quantities, and always seeking an equilibrium, great abundance may sometimes collect through various causes in a particular spot, whence it will be attracted to another less charged with this astonishing fluid; when the tremendous conflict between it and the air is remembered during a storm in our atmosphere, we must readily admit that it may produce a strong concussion in the earth, and probably be the origin of the slight earthquakes peculiar to some countries.

Another cause of inconsiderable tremblings, may perhaps proceed from the operations of subterraneous streams, which rushing through caverns, and undermining vast bodies of earth and stone, those fall and shake the neighbouring parts in proportion to their bulk and weight. When the motion of the sea, during an earthquake, had destroyed the support of Port Royal, in Jamaica, the town sunk into it; in the same manner new cavities occurring through the fall of earth, the surface must necessarily sink in the same degree, if it is within the influence of the cause.

Frezier is of opinion that earthquakes should be ascribed to an effect of the waters, which appear to moisten the earth, in passages similar to the veins of living bodies. Now the waters may occasion earthquakes after several manners, either by dissolving the salt scattered through the earth, or by penetrating through porous lands, mixed with stones, which they insensibly loosen; and the fall or removal thereof must cause a stroke or shock, such as is felt in earthquakes. Lastly, the water penetrating some sulphurous bodies must there cause a fermentation, and then the heat produces foul exhalations, which infect the air when they open the earth."

This extract from a narrative of the dreadful earthquakes at Lima in 1746, is illustrated by the experiment of M. Lemery related in the memoirs of the French Academy of Sciences for 1700; that gentleman having mixed equal quantities of filings of iron and sulphur, and tempered them with water into the consistence of paste, buried them; they some time afterwards agitated the earth, and finally burst into a flame. To confirm this effect of fire, however generated in the bowels of the earth, we shall quote the following paragraph from that accurate modern observer Spallanzani, who was indebted to Professor Bottis for the facts contained in it, which relate to the production of seven small mountains by the eruption of Vesuvius in 1760. After repeated concussions of the earth, which were felt fifteen miles round Vesuvius, the sides of the fiery mountain opened in the territory of the Torre del Greco, and fifteen volcanoes appeared, eight of which were soon after covered by a torrent of lava, which rushed from one of them; the other seven remaining entire, and incessantly ejecting from their mouths vast quantities of ignited substances, which falling almost perpendicularly around the volcanos, produced, in the short space of ten days, seven small mountains, of various heights, disposed in a right line. During these ejections, the noise which accompanied them sometimes resembled that of violent thunder, and at others the discharge of number of cannons. Several of the burning stones, even the largest, were thrown to the height of 960 feet, and some fell at a considerable distance from the mouths whence they were thrown. These eructations shook all the neighbouring country, and the roarings of the mountain were dreadful to the inhabitants.

That there are many substances existing within the depth of the earth, which, coalesced, produce fire, cannot be disputed, but that they exist in such amazing quantities as to afford fire for centuries, seems at least problematical; there is therefore but two ways of accounting for their continuance, either that the volatile effluvia of the ignited matter, collected on the sides of volcanic caverns, becomes new fuel; or that heat being necessary for the various properties of the globe, a self-existent fire, coeval with the creation, has been placed within it by the wisdom of the Creator, an idea not of more doubtful evidence than the existence of the electric fluid invisible, or any other of the phenomena of nature by which we are surrounded. (See Volcano). Admitting these premises, another cause of earthquakes occurs; it is well known, that volcanos communicate with the sea, by the frequent discharge of saline water and tufa, or the slime and mud of its

bottom through their craters; this interfering with the operations of the fire, vast bodies of steam must ensue, than which nothing can be more powerful and insinuating; this rushing by the force of violent explosions through every aperture of the various stratas of the surrounding earth, must occasion those horizontal and perpendicular movements and tremblings, so terrific to the inhabitants above; besides, hot steams, impregnated with sulphurous vapours, often attend earthquakes.

Homer, whose knowledge was extensive, seems to have been aware that the sea caused earthquakes, several instances of which might be quoted from the Iliad:

> "But Neptune rising from the seas profound,
> The God whose earthquakes rock the solid ground." Book xiii. l. 67.

And in the xxth book, line 77.

> "Beneath, stern Neptune, shakes the solid ground;
> The forests wave, the mountains nod around;
> Through all their summits tremble Ida's woods,
> And from their sources boil her hundred floods."

Indeed the sudden eruption of stones and calcined matter seem unquestionably the effect of water flying off in steam, and carrying every loose object with it. The sea, or water of any great extent always indicates the commencement of an earthquake before it is otherwise perceived, this circumstance doth not proceed from any cause peculiar to the component parts of the water, but merely from the motion of the earth under the bottom, which is not felt by a person on the adjacent shore, probably from its gliding steadily in one direction, and returning in the same manner; but water ever seeking a level will rise at the remotest influence from the land, as that inclines towards it, and then rush precipitately back to its previous level, as far as it can be attained, before another inclination of the earth prevents it. The sea is observed to retire before the eruptions of Vesuvius, which is evidently caused by the rising of the earth during the first efforts of the matter endeavouring to escape out of the mountain; when that is discharged the water flows back again impetuously, plainly indicating that the earth has again sunk to its original place; the same effect was noticed at Lisbon, as far as related to the dreadful agitation of the sea, from which vessels received violent shocks at fifty leagues distance, indeed the effects of that earthquake, so fatal to the city above named in 1755, were felt throughout Europe and America.

Having detailed some of the probable causes of earthquakes, it will be proper to mention the indications of their approach in those countries were they are most prevalent, which is in Mexico, Peru, Jamaica, and the neighbouring islands; Italy, particularly in Sicily, Asia minor, and Portugal; they are felt in almost every other country, but so slightly as seldom to occasion serious injury. Beginning near their visible causes, where they are necessarily most frequent, it may be observed that when a long interval has occurred from the last eruption of a volcano, there is just reason for alarm, that the succeeding will be introduced by violent concussions of the earth. There are some phenomena which attend earthquakes of decided certainty, others may happen accidentally near the time of their approach, and be attributed erroneously to them; such as very dry and hot seasons, which undoubtedly take place frequently where shocks are but little known, and dark atmospheres caused by unusual vapours; of the latter, many instances are recorded without the least calamity following, indeed the case of Lisbon is directly in point against this being universally an indication of earthquake, for the morning of that dreadful day was particularly fine, and the sun shone with the utmost brilliancy. Neither is the sudden ebbing and flowing of the sea, or rivers, always to be depended upon as the forerunner of convulsions of the earth, though it is uniformly the consequence of them, as such effects have been observed without any assignable cause. Electrical phenomena sometimes attend them, in violent streams of lightening, the aurora borealis, meteors, &c. but as these are common appearances they afford no just cause of alarm if a trembling of the earth doth not very soon succeed.

If the clear water of deep wells suddenly becomes heated and impregnated with soil, and an unusual stillness of the air prevails, and cattle evince great restlessness and terror, well founded apprehensions may be entertained of an approaching earthquake, which will commence with slight trembling motion, perceivable in the most fleshy parts

of the body, accompanied by a deep hollow sound, indescribable, yet resembling distant thunder, combined with the roar of numerous cannons. The most violent and dangerous shocks are undulatory, horizontal, and perpendicular, the two latter are most dreadful in their consequences, by throwing down the strongest edifices, and making those horrible chasms which engulph every object within their boundaries, emit pestilential vapour, heated water, sand, smoke, and flames: each particular shock seldom exceeds a minute in duration, but they often follow one another with great rapidity.

Such are the indications aud peculiarities attending earthquakes; the following short narratives of their consequences, in different places, will enable the reader who has happily escaped feeling to justly understand them.

"There is no part of the world perhaps so subject to earthquakes as Peru; nor any part of Peru more liable to them than Lima and its neighbourhood. On Monday, October 20, 1687, N. S. at 4 o'clock in the morning, there arrived a most horrible earthquake, which threw down some houses, and buried several persons under their ruins. An hour after there was another shake, accompanied with the same noise; and at six o'clock, when they thought they had been all in safety, came a third shock, with great fury and a rushing noise; the sea, with hideous roaring, swelled beyond its bounds; the bells rang of themselves; and the destruction was so great that no building was left standing. The noise was so dreadful, says P. Alvarez de Toledo, (who sent the account from thence) that those in the fields assure us the cattle were in great astonishment: he adds, Callao, Canete, Pisco, Chaucay, and Los Chorillos, are all ruined: above 5000 dead bodies are already found, and they find more daily."

Lima was destroyed in the night of October 28, 1746, the anniversary of St. Simon and St. Jude. "According to the best regulated clocks and watches, this fatal catastrophe befel the place thirty minutes after ten at night; on this occasion the destruction did not so much as give time for fright, for at one and the same instant almost, the noise, the shock, and the ruin were perceived together; so that in the space only of four minutes, during which the greatest force of the earthquake lasted, some persons were buried under the ruins of the falling houses; and others crushed to death in the streets by the tumbling of the walls, which, as they ran here and there, fell upon them. The earth struck against the edifices with such violent percussions, that every shock beat down the greater part of them; and these tearing along with them vast weights in their fall (especially the churches and high houses), completed the destruction of every thing they encountered with, even of what the earthquake had spared. The shocks, although instantaneous, were yet successive; and at intervals men were transported from one place to another, which was the means of safety to some, whilst the utter impossibility of moving preserved others."

The second edition of Mr. Swinburne's Travels in the Two Sicilies contains the ensuing most affecting letter, written by a person who witnessed the scenes he described.

"On the 5th of February, at 19 hours and 3 quarters, we felt a shock that began by an upward heaving motion, which gave the alarm, and time to most persons to run out of their houses: some fled to the windows and balconies; others took refuge under the arches of the doors. This upright motion of the earth was soon succeeded by shaking and rocking, during which we beheld our houses tumbling on all sides. The walls and towers of the castle were split asunder, and overturned upon the town; the buildings below were crushed to atoms, and 150 persons perished in this fall. At night a considerable part of the inhabitants, chiefly of the class of sailors, followed the example of the prince, and repaired to the beach; they there pitched tents, or lay down in their barks, hoping to pass the night in perfect security at a distance from all buildings. The sky was bright and serene, the sea lulled in a profound calm, and all these poor people were indulging in sweet sleep a short respite from their woes. In this treacherous state of things, a little after midnight the whole promontory of Campala fell at once into the sea, without any previous earthquake. The sea fled back before this mass towards the Golilla del Faro, where it carried off 28 persons with their boats and houses; then returning with redoubled fury across its natural channel, flowed on the shore of Scylla 30 palms above its usual level, and three miles along the coast. As it fell back again, it swept away into the abyss 2,475 persons, who were lying on the sands or in boats. Horrible were the shrieks of the survivors, who happened to be above the reach of the

surge, and tremendous was the alarm given over all the surrounding hills, where the remainder of the inhabitants were dispersed for safety. No cries, no lamentation, were heard from those that were thus hurried off; they had no power or time to utter any."—"The same instant (says Mr. S.) was fatal to the whole province, and the devastation caused by the repeated shocks was much more terrible in many places than at Scylla; they raged with fury from Cape Spartivento to Amantea, above the gulph of St. Eufemia, and also affected that part of Sicily which lies opposite to the southern extremity of Italy. Those of the 5th and 7th of February, and of the 28th of March, 1783, were the most violent, and completed the destruction of every building throughout the above-mentioned space. Not one stone was left upon another south of the narrow isthmus of Squillace; and what is more disastrous, a very large proportion of the inhabitants was killed by the falling of their houses: near 40,000 lives were lost. Some persons were dug out alive, after remaining a surprising length of time buried in the rubbish. Messina became a mass of ruins; its beautiful Palazzata was thrown in upon the town; its quay cracked into ditches full of water. Reggio almost destroyed. Tropea greatly damaged. Every other place I visited in the province levelled to the ground.

"Before and during the concussion the clouds gathered, and then hung immoveable and heavy over the earth. At Palmi the atmosphere wore so fiery an aspect, that many people thought part of the town was burning. It was afterwards remembered that an unusual heat had affected the skin of several persons just before the shock; the rivers assumed a muddy, ash-coloured tinge, and a sulphureous smell was almost general. A frigate passing between Calabria and Lipari felt so severe a shock, that the steersman was thrown from the helm, and the cannons were raised up on their carriages, while all around the sea exhaled a strong smell of brimstone. Stupendous alterations were occasioned in the face of the country: rivers choaked up by the falling in of the hills were converted into lakes; whole acres of ground, with houses and trees upon them, were broken off from the plains, and washed many furlongs down the deep hollows which the course of the rivers had worn; there, to the astonishment and terror of beholders, they found a new foundation to fix upon, either in an upright or an inclining position. In short, every species of phenomenon incident to these destructive commotions of the earth was to be seen in its utmost extent and variety in this ruinated country."

EASEL *pieces*, a denomination given by painters to such pieces as are contained in frames, in contradistinction from those painted on ceilings, &c.

EASEMENT, a service on convenience, which one neighbour has of another by grant, or prescription, as a way through his ground, a sink, or the like.

EASING, in the sea-language, signifies the slackening a rope, or the like: thus, to ease the bow-line or sheet, is to let them go slacker; to ease the helm, is to let the ship go more large, more before the wind, or more larboard.

EAST, one of the four cardinal points of the world; being that point of the horizon, where the sun is seen to rise when in the equinoctial.

EASTER, a festival of the christian church, observed in memory of our Saviour's resurrection.

In the primitive ages of the church, there were very great disputes about the particular time when this festival was to be kept. The Asiatic churches kept their Easter upon the very same day the Jews observed their passover; and others, on the first Sunday after the first full moon in the new year. This controversy was determined in the council of Nice, when it was ordained that Easter should be kept upon one and the same day, which should always be a Sunday, in all christian churches throughout the world.

But though the Christian Churches differed as to the time of celebrating Easter, yet they all agreed in shewing particular respect and honour to this festival: hence, in ancient writers, it is distinguished by the name of *dominica gaudii, i. e.* Sunday of joy. On this day prisoners and slaves were set free, and the poor liberally provided for. The eve, or vigil, of this festival was celebrated with more than ordinary pomp, which continued till midnight, it being a tradition of the church that our Saviour rose a little after midnight; but in the east, the vigil lasted till cock-crowing.

It was in conformity to the custom of the Jews, in celebrating their passover on the fourteenth day of the first month, that the primitive fathers ordered, that the fourteenth day of the moon, from the calendar new moon, which immediately follows the

twenty-first of March, at which time the vernal equinox happened upon that day, should be deemed the paschal full moon, and that the Sunday after should be Easter-day; and it is upon this account that our rubric has appointed it upon the first Sunday after the first full moon immediately following the twenty-first day of March. Whence it appears, that the true time for celebrating Easter, according to the intention of the council of Nice, was to be the first Sunday after the first full moon following the vernal equinox, or when the sun entered into the first point of aries; and this was pope Gregory's principal view in reforming the calendar, to have Easter celebrated according to the intent of the council of Nice.

Having first found the epact and dominical letter, according to the method delivered: see CHRONOLOGY and EPACT, Easter-day may be found by the two following rules.

1. To find Easter-limit, or the day of the paschal full moon, counted from March 1 inclusive, the rule is this: add 6 to the epact, and if this sum exceeds 30, take 30 from it; then from 50 subtract this remainder, and what is left will be the limit; if the sum of the epact, added to 6, does not amount to 30, it must be subtracted from 50, and the remainder is the limit required; which is never to exceed 49, nor fall short of 21.

2. From the limit and dominical letter, to find Easter-day: add 4 to the dominical letter; subtract this sum from the limit, and the remainder from the next higher number which contains 7 without any remainder; lastly, add this remainder to the limit, and their sum will give the number of days from the first of March to Easter-day, both inclusive.

Thus, to find Easter-day for the year 1808, for instance. First find the epact 3, which added to 6 gives 9: and as this sum does not amount to 30, it must be subtracted from 50, and the remainder 41 is the limit. Then adding 4 to 2, the number of the dominical letter B subtract this sum, *viz.* 6, from the limit 41, and the remainder 35 from 42, the next superior number that contains 7 a certain number of times without any remainder, and there remains 7, which being added to the limit 41, gives 48 for the number of days from the first of March to Easter-day, both inclusive: hence, allowing 31 for March, there remains the 17th of April for Easter-day. Here follows the operation at length.

$3 + 6 = 9$
$50 - 9 = 41 =$ paschal limit
Dominical letter $B = 2$
$2 + 4 = 6$
$41 - 6 = 35$
$42 - 35 = 7$
$41 + 7 = 48$ from which subtracting
31, the number of days in March,
17 there remains 17, the day of April answering to Easter-day for the year 1808.

EASTLAND *company*, under charter from Queen Elizabeth in 1579, traded to the east country, meaning the ports in the Baltic, but by statute 25 Car. II. c. 7, all persons may use the Eastland trade; and they may be admitted a free member of the company for 40*s*.

EAU *de Luce*, a fragrant liquor, possessing and retaining a milky opacity, made chiefly of mastic dissolved in alcohol, to which are added, elemi and aqua ammoniæ puræ. See Nicholson's Journal.

EBENUS, in botany, a genus of the Diadelphia Decandria class and order. Essential character: calyx with teeth, the length of the corolla; wings scarcely any; seed one, rough with hairs. There are two species, *viz.* E. cretica, Cretan ebony, and E. pinnata, pinnated ebony: the former grows naturally in Crete, and some islands of the Archipelago; the latter is found in Barbary and the Levant.

EBIONITES, in church history, heretics of the first century, so called from their leader Ebion. They held the same errors with the Nazarenes, united the ceremonies of the mosaic institution with the precepts of the gospel, observed both the Jewish sabbath and Christian Sunday, and in celebrating the Eucharist, made use of unleavened bread. They abstained from the flesh of animals, and even from milk. In relation to Jesus Christ, some of them held that he was born, like other men, of Joseph and Mary, and acquired sanctification only by his good works. Others of them allowed that he was born of a Virgin, but denied that he was the word of God, or had any existence before his human generation. They said, he was, indeed, the only true prophet; but yet a mere man, who by his virtue had arrived at being called Christ, and the son of God. They also supposed that Christ and the devil were two principles, which God had op-

posed to each other. Of the New Testament they only received the gospel of St. Matthew, which they called the gospel according to the Hebrews. See the article Nazarenes.

EBONY is an exceedingly hard and heavy kind of wood, susceptible of a very fine polish, and on that account used, in mosaic and inlaid works, for toys, &c. It is of divers colours, most usually black, red, and green; produced chiefly in the island of Madagascar and the Mauritius. Travellers give very different accounts of the tree that yields the black ebony; some say that it is a sort of palm tree, others a cytisus, &c. M. Flacourt tells us, that it grows very high and big, its bark being black, and its leaves resembling those of the myrtle, of a deep, dusky, green colour. Black ebony is much preferred to that of other colours. The best is a jet black, free from veins and rind, very massive, astringent, and of an acrid pungent taste. It yields an agreeable perfume when laid on burning coals: when green it readily takes fire from the abundance of its fat. Green ebony, besides Madagascar and the Mauritius, likewise grows in the Antilles, especially in the isle of Tobago. The tree that yields it is very bushy; its leaves are smooth, and of a fine green colour. Beneath its bark is a white rind about two inches thick; all under which, to the very heart, is a deep green, approaching towards a black, though sometimes streaked with yellow veins. Its use is not confined to inlaid work, it is likewise good in dyeing, as yielding a fine green tincture.

Ebony is now less used than anciently, since the discovery of giving other hard woods a black colour. There is a sort of ebony coming from the West Indies, which is either black or white. This bears a flower resembling that of the English broom; seldom rises above eighteen feet, and in the largest part of the stem, does not exceed five inches diameter. It is a fine timber wood, has a smooth even grain, which takes a good polish, and is very proper for bed-posts, and a variety of turnery ware; for which purposes the black is generally preferred, the heart of which is the complexion of jet. There is likewise a bastard ebony, growing in the West India islands, called mountain ebony, which is of a dark brown. See Amerimum.

EBULLITION. See Boiling.

ECHINEIS, the *remora*, in natural history, a genus of fishes of the order Thoracici. Generic character: head furnished on the top with a flat, oval, transversely-grooved shield; gill-membrane, with ten rays, according to Gmelin, and six according to Shaw; body not scaled. There are three species, the echineis remora, or Mediterranean remora is of the length of from twelve to eighteen inches. Among the ancients its peculiarity of structure and habits was connected with the most incredible and marvellous circumstances, which are, however, detailed with all possible gravity and faith, by their most profound naturalists. Pliny states, that the force of the tide, the current, and the tempest, joining in one grand impulse with oars and sails, to urge a ship onwards in one direction, is checked by the operation of one small fish, called remora, by the Roman authors, which completely counteracts this apparently irresistible accumulation of power, and compels the vessel to remain motionless in the midst of the ocean. He credits the prevailing report that Anthony's ship in the battle of Actium was kept motionless by the exertion of the remora, notwithstanding the efforts of several hundred sailors; and that the vessel of Caligula was detained between Astura and Antium by another of these fishes, found sticking to the helm, and whose solitary efforts could not be countervailed by a crew of 400 able seamen, till several of the latter on examining into the cause of the detention, perceived the impediment, and detached the remora from its hold. The Emperor, he adds, was not a little astonished, that the fish should hold the ship so fast in the water, and when brought upon the deck, appear to possess no power of detention over it whatever. This confiding naturalist expresses himself as perfectly convinced, that all fishes possess a similar power, and states as a notorious example, the detention of Periander's ship by a porcellane, near the Cape of Gnidos. Quitting, however, the fables of antiquity, it may be observed, that the fins of the remora are particularly weak, and thus prevent its swimming to any considerable distance, on which account it attaches itself to various bodies, inanimate or living, being found not only fastened to ships, but to whales, sharks, and other fishes; and with such extreme tenacity is this hold maintained, that, unless the effort of separation be applied in a particular direction, it is impossible to effect the disunion without

the destruction of the fish itself. As the remora is extremely voracious, and far from fastidious in its food, it may attach itself to vessels and large fishes, with a view to secure that ample subsistence which must arise to it from the superfluity with which it is in such circumstances almost inevitably furnished. This fish will often adhere to rocks, and particularly in boisterous and tempestuous weather. The apparatus for accomplishing this adhesion, consists of an oval area on the top of the head, traversed by numerous dissepiments, each of which is fringed at the edge by a row of very numerous perpendicular teeth, or filaments, while the whole oval space is strengthened by a longitudinal septum. It is reported by some authors, that, in the Mozambique channel, a species of remora is employed by the natives of the coast in their pursuit of turtles with great success. A ring is fixed near the tail of the remora with a long cord attached to it, and when the boat has arrived as nearly as it well can to the turtle sleeping on the surface of the water, the remora is dismissed and immediately proceeds towards the turtle, which it fastens on so firmly, that both are drawn into the boat with extreme facility. For a representation of the Mediterranean remora, see Pisces, Plate IV. fig. 3.

ECHINOPHORA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: lateral flowers male; central hermaphrodite; seed one, immersed in an involucel. There are two species, *viz.* E. spinosa, prickley sea-parsnip, and E. tenuifolia, fine-leaved sea-parsnip. Natives of the sea coast of Europe and Apulia.

ECHINOPS, in botany, *globe thistle*, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx one-flowered; corolla tubular, hermaphrodite; receptacle bristly; down obscure. There are five species. These are herbaceous plants, some of them large and lofty; leaves alternate, thorny and pinnatified; the heads of flowers are usually solitary at the end of the stem and branches.

ECHINORYNCHUS, in natural history, a genus of the Vermes Intestina; body round; proboscis cylindrical retractile, and crowned with hooked prickles. These animals are found fixed very firmly to the viscera of various animals, generally the intestines; and often remain on the same spot during the whole life of the animal; they are mostly gregarious, and are easily distinguished from the tænia by their round inarticulate body. They are divided into sections: A. infesting mammalia, of this E. gigas is found in the intestines of swine, especially those that have been fed in styes: it is gregarious, and from 12 to 18 inches long. B. infesting birds. C. infesting reptiles. D. infesting fish. There are about 50 species.

ECHINUS, *sea-urchin*, in natural history, a genus of the Vermes Mollusca; body roundish, covered with a bony sutured crust, and generally furnished with moveable spines; mouth placed beneath, and mostly five-valved. These are divided into sections, chiefly distinguished by the situation of the vent. A. has the vent vertical; tentacula every where simple. B. vent placed beneath; mouth without tentacula. C. vent lateral; mouth with pencilled tentacula. Each of these sections are subdivided. There are more than 100 species, besides varieties. They are all inhabitants of the sea, and many of them have been found in a fossil state; many are esculent, and they are in general armed with five sharp teeth; the pores are each furnished with a retractile tentaculum, by which the animal affixes itself to any object and stops its motion; the spines are connected to the outer skin by very strong ligaments, and are the instruments of motion.

ECHITES, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, long and straight; seeds downy; corolla funnel form, with the throat naked. There are twenty-two species. These plants have something singular in their habit which proclaims them at first sight. The nectareous glands, and the downy seeds in follicles, are of great importance in determining the character; whilst the corolla, varying much in the different species, is of no consequence in this respect. The stigmas in all are glued to the inside wall of the cone formed by the anthers, and which separates at the explosion of the pollen, whilst the outer wall of the cone continues undissolved; the fecundation in the greater part being accomplished within the closed tube of the corolla, but in the rest within the cone stretched beyond the tube. These plants are mostly inhabitants of the West Indies. They have not yet been introduced into cultivation in Europe.

ECHIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla irregular, with the throat naked. There are twenty-one species, of which E. fruticosum, shrubby vipers bugloss, rises with a shrubby stalk two or three feet high, dividing at top into several branches; leaves sessile, hairy, light green. The flowers are produced singly between the leaves at the ends of the branches; they are of a purple colour, and in shape much like those of the Cretan sort. They appear in May and June; the seeds do not ripen in England. Native of the Cape of Good Hope.

ECHO, a sound reverberated or reflected to the ear from some solid body. See ACOUSTICS.

ECHO, in architecture, a term applied to certain kinds of vaults and arches, most commonly of elliptical and parabolical figures, used to redouble sounds, and produce artificial echoes.

ECHO, in poetry, a kind of composition wherein the last words or syllables of each verse contain some meaning, which being repeated apart, answers to some question or other matter contained in the verse, as in this beautiful one from Virgil:

Crudelis mater magis, an puer improbus ille?
Improbus ille puer, crudelis tu quoque mater.

The elegance of an echo consists in giving a new sense to the last words; which reverberate, as it were, the motions of the mind, and by that means affect it with surprise and admiration.

ECHO, in music, is frequently found in church voluntaries, over those passages of repetitions which are performed on the swell, and intended as echoes to the great organ.

ECHOMETER, among musicians, a kind of scale or rule, with several lines thereon, serving to measure the duration and length of sounds, and to find their intervals and ratios.

ECLECTICS, ancient philosophers, who, without attaching themselves to any particular sect, selected whatever appeared to them the best and most rational, from each.

ECLIPSE, the deprivation of the light of the sun, or of some heavenly body, by the interposition of another heavenly body between our sight and it. Thus, eclipses of the sun happen by the moon's intervening between it and the earth; by which means the shadow of the moon falls upon the earth, when the latitude of the moon does not prevent it, by elevating the moon above, or depressing it below the earth. On the other hand, an eclipse of the moon can only happen when the earth is interposed between the sun and it; for then, if the latitude of the moon does not prevent it, the shadow of the earth may fall on the moon, and thereby cause either a partial or total eclipse. A total eclipse of the sun or moon is when their whole bodies are obscured; and a partial one is when part only of their bodies is darkened: again, a central eclipse is when it is not only total, but the eclipsed body passes through the centre of the shadow. See ASTRONOMY.

As total solar eclipses are by no means common, we shall give an interesting description of one, by Dr. Stukeley, sent to his friend the celebrated Dr. Edmund Halley.

"According to my promise, I send you what I observed of the solar eclipse, though I fear it will not be of any great use to you. I was not prepared with any instruments for measuring time or the like, and proposed to myself only to watch all the appearances that nature would present to the naked eye upon so remarkable an occasion, and which generally are overlooked, or but grossly regarded. I chose for my station a place called Haradon Hill, two miles eastward from Amsbury, and full east from the opening of Stonehenge avenue, to which it is as the point of view. Before me lay the vast plain where that celebrated work stands, and I knew that the eclipse would appear directly over it; beside, I had the advantage of a very extensive prospect every way, this being the highest hill hereabouts, and nearest the middle of the shadow; full west of me, and beyond Stonehenge, is a pretty copped hill, like the top of a cone, lifting itself above the horizon; this is Clay-hill near Warminster, 20 miles distant, and near the central line of darkness, which must come from thence, so that I could have notice enough before hand of its approach. Abraham Sturgis and Stephen Ewens, both of this place and sensible men, were with me. Though it was very cloudy, yet now and then we had gleams of sunshine, rather more than I could perceive at any other place around us. These two persons looking through smoaked glasses, while I was taking some bearings of the

country with a circumferentor, both confidently affirmed the eclipse was begun, when by my watch I found it just half an hour after 5; and accordingly from thence the progress of it was visible, and very often to the naked eye; the thin clouds doing the office of glasses. From the time of the sun's body being half covered, there was a very conspicuous circular iris round the sun with perfect colours. On all sides we beheld the shepherds hurrying their flocks into fold, the darkness coming on; for they expected nothing less than a total eclipse for an hour and a quarter.

"When the sun looked very sharp like a new moon, the sky was pretty clear in that spot; but soon after a thicker cloud covered it, at which time the iris vanished, the copped hill before-mentioned grew very dark, together with the horizon on both sides, that is to the north and south, and looked blue; just as it appears in the east at the declension of day. We had scarce time to tell ten, when Salisbury steeple six miles off southward became very black: the copped hill quite lost, and a most gloomy night with full career came upon us: at this instant we lost sight of the sun, whose place among the clouds was hitherto sufficiently distinguishable, but now not the least trace of it to be found, no more than if really absent: then I saw by my watch, though with difficulty, and only by help of some light from the northern quarter, that it was 6 hours 35 minutes: just before this the whole compass of the heavens and earth looked of a lurid complexion, properly speaking, for it was black and blue, only on the earth upon the horizon the blue prevailed; there was likewise in the heavens among the clouds much green interspersed, so that the whole appearance was really very dreadful, and as symptoms of sickening nature.

"Now I perceived us involved in total darkness and palpable, as I may aptly call it; though it came quick, yet I was so intent that I could perceive its steps, and feel it as it were drop upon us, and fall on the right shoulder (we looking westward) like a great dark mantle or coverlet of a bed thrown over us, or like the drawing of a curtain on that side; and the horses we held in our hands were very sensible of it, and crowded close to us, startling with great surprise; as much as I could see of the men's faces that stood by me, had a horrible aspect; at this instant I looked around me, not without exclamations of admiration, and could discern colours in the heavens, but the earth had lost its blue, and was wholly black; for some time among the clouds there were visible streaks of rays, tending to the place of the sun as their centre; but immediately after, the whole appearance of earth and sky was entirely black: of all things I ever saw in my life, or can by imagination fancy, it was a sight the most tremendous.

"Toward the north-west, whence the eclipse came, I could not in the least find any distinction in the horizon between heaven and earth, for a good breadth, of about 60 degrees or more; nor the town of Ambsbury underneath us, nor scarce the ground we trod on: I turned myself round several times during this total darkness, and remarked at a good distance from the west on both sides, that is to the north and south, the horizon very perfect; the earth being black, the lower part of the heavens light; for the darkness above hung over us like a canopy, almost reaching the horizon in those parts, or as if made with skirts of a lighter colour; so that the upper edges of all the hills were as a black line, and I knew them very distinctly by their shape or profile; and northward I saw perfectly, that the interval of light and darkness in the horizon was between Martinsal hill and St. Ann's hill; but southward it was more indefinite: I do not mean that the verge of the shadow passed between those hills, which were but 12 miles distant from us; but, so far I could distinguish the horizon, beyond it not at all: the reason of it is this: the elevation of ground I was upon gave me an opportunity of seeing the light of the heavens beyond the shadow; nevertheless, this verge of light looked of a dead, yellowish, and greenish colour; it was broader to the north than south, but the southern was of a tawny colour; at this time behind us, or eastward toward London, it was dark too, where otherwise I could see the hills beyond Andover; for the foremost end of the shadow was past thither; so that the whole horizon was now divided into four parts of unequal bulk, and degrees of light and dark; the part to the north-west broadest and blackest, to the south-west lightest and longest. All the change I could perceive during the totality, was that the horizon by degrees drew into two parts, light and dark; the northern hemisphere growing still longer, lighter, and

broader; and the two opposite dark parts uniting into one, and swallowing up the southern enlightened part.

"As at the beginning the shade came feelingly upon our right shoulders, so now the light from the north, where it opened as it were; though I could discern no defined light or shade upon the earth that way, which I earnestly watched for, yet it was manifestly by degrees, and with oscillations, going back a little, and quickly advancing further, till at length upon the first lucid point appearing in the heavens, where the sun was, I could distinguish pretty plainly a rim of light running along side of us a good while together, or sweeping by at our elbows from west to east, just then having good reason to suppose the totality ended with us, I looked on my watch and found it to be full three minutes and a half more. Now the hill tops changed their black into blue again, and I could distinguish a horizon where the centre of darkness was before; the men cried out they saw the copped hill again, which they had eagerly looked for; but still it continued dark to the south-east, yet I cannot say that ever the horizon that way was undistinguishable; immediately we heard the larks chirping, and singing very briskly, for joy of the restored luminary, after all things had been hushed into a most profound and universal silence. The heavens and earth now appeared exactly like morning before sun-rise, of a greyish cast, but rather more blue interspersed; and the earth, so far as the verge of the hill reached, was of a dark-green or russet colour.

"As soon as the sun emerged, the clouds grew thicker, and the light was very little amended for a minute or more, like a cloudy morning slowly advancing. After about the middle of the totality, and so after the emersion of the sun, we saw Venus very plainly, but no other star. Salisbury steeple now appeared. The clouds never removed, so that we could take no account of it afterward, but in the evening it lightened very much. I hasted home to write this letter; and the impression was so vivid upon my mind, that I am sure, I could for some days after have wrote the same account of it, and very precisely. After supper I made a drawing of it from my imagination, upon the same paper I had taken a prospect of the country before.

"I must confess to you, that I was (I believe) the only person in England that regretted not the cloudiness of the day, which added so much to the solemnity of the sight, and which incomparably exceeded, in my apprehension, that of 1715, which I saw very perfectly from the top of Boston steeple, in Lincolnshire, where the air was very clear; but the night of this was more complete and dreadful: there, indeed, I saw both sides of the shadow come from a great distance, and pass beyond us to a great distance; but this eclipse had much more of variety and majestic terror; so that I cannot but felicitate myself upon the opportunity of seeing these two rare accidents of nature, in so different a manner: yet I should willingly have lost this pleasure for your more valuable advantage of perfecting the noble theory of the celestial bodies, which last time you gave the world so nice a calculation of; and wish the sky had now as much favoured us for an addition to your honour and great skill, which I doubt not to be as exact in this as before."

ECLIPTA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compound Flowers. Corymbiferæ, Jussieu. Essential character: receptacle chaffy; down none; corollets of the disk four-cleft. There are five species, natives of the East and West Indies.

ECLIPTIC, in astronomy, a great circle of the sphere, supposed to be drawn through the middle of the zodiac, making an angle with the equinoctial of about 23° 30′, which is the sun's greatest declination: or, more strictly speaking, it is that path or way among the fixed stars, that the earth appears to describe, to an eye placed in the sun.

By a long series of observations, the shepherds of Asia were able to mark out the sun's path in the heavens; he being always in the opposite point to that which comes to the meridian at midnight, with equal, but opposite declination. Thus they could tell the stars among which the sun then was, although they could not see them. They discovered that this path was a great circle of the heavens, afterwards called the ecliptic; which cuts the equator in two opposite points, dividing it, and being divided by it into two equal parts. They farther observed, that when the sun was in either of these points of intersection, his circle of diurnal revolution coincided with the equator, and therefore the days

and nights were equal. Hence the equator came to be called the equinoctial line, and the points in which it cuts the ecliptic were called the equinoctial points, and the sun was then said to be in the equinoxes. One of these was called the vernal, and the other the autumnal equinox. See EQUINOXES.

ECLIPTIC, *obliquity of*, is the angle which its plane makes with that of the equinoctial. The inclination of the equator to the ecliptic is measured by the arch of a great circle intercepted between their poles, which was taken with very great accuracy by Dr. Maskelyne, in the year 1769, and found to be 23° 28′ 10″, or 23° 46944. It was formerly found by Dr. Bradley to be 23° 28′ 30″, who supposed that there was a gradual approach of the ecliptic to the equinoctial at the rate of 1′ in 100 years. The mean obliquity of the ecliptic, is augmented by 9″, when the moon's ascending node is in the vernal equinox. It is on the contrary, diminished 9″, when the node is in the autumnal equinox, and it is equal to the mean when the node is in the colure of the solstices. This change of the inclination of the earth's axis to the plane of the elliptic was called the nutation of the axis by Sir Isaac Newton.

Dr. Bradley discovered a general and periodical motion in all the stars, which alter a little their relative situations. To form an idea of this motion, let us suppose that each star describes annually a small circumference parallel to the ecliptic, whose centre is the mean position of the star, and whose diameter, as seen from the earth, subtends an angle of about 40″; and that it was in that circumference as the sun in its orbit, but so that the sun always precedes it by 90°. This circumference, projected upon the surface of the celestial sphere, appears under the form of an ellipse, more or less flattened according to the height of the star above the equator, the smaller axis of the ellipse being to the greater axis as the sine of that height to the radius. These periodical movements of the stars have received the name of aberrations of the fixed stars. See ABERRATION.

ECLIPTIC, in geography, a great circle on the terrestrial globe, not only answering to, but falling within the plane of the celestial ecliptic. See GLOBES, *use of*.

ECLOGUE, in poetry, a kind of pastoral composition, or a small elegant poem, in a natural simple style.

The eclogue, in its primary intention, is the same thing with the idyllium, but custom has made some difference between them, and appropriated the name of eclogue to pieces wherein shepherds are introduced, and idyllium to those written like eclogues, but without any shepherds in them. The eclogue then is properly an image of pastoral life, upon which account the matter is low, and its genius humble. Its business is to describe the loves, sports, piques, jealousies, intrigues, and other adventures of shepherds; so that its character must be simple, the wit easy, and the expression familiar. Then the true character of the eclogue is simplicity and modesty; its figures are neat, the passions tender, the motions easy, and though sometimes it may have little transports and despairs, yet it never rises so high as to be fierce or violent. Its narrations are short, descriptions little, the thoughts ingenuous, the manners innocent, the language pure, the verse flowing, the expressions plain, and all the discourse natural.

ECONOMY, *political*. Political economy is the science which treats of the wealth of nations. Its object is to ascertain, in the first place, wherein wealth consists, and then to explain the causes of its production, and the principles on which it is distributed through the different orders of society. It likewise endeavours to point out the tendency which any political regulations may have to favour or to injure the productions or most advantageous distribution of wealth. Such is its peculiar object, and consequently though writers on political economy may frequently treat on the more important topics of national security, freedom and happiness, these are then passing the strict limits of their science.

Political economy, in some of its branches, has engaged the attention of speculative men in all ages; but it is only in very recent times that the truths it exhibits have been collected, arranged, and demonstrated with such precision, as to entitle it to the name and dignity of a science.

The writers on political economy may be arranged in two great classes; the former composed of those who regard commerce, and the latter of those who regard agriculture as the principal source of national wealth. Almost all the older writers belong to the former class. The most considerable English writers of this class are Dr. d'Avenant and Sir John Stewart, and their principles are interwoven in the elabo-

rate history of Commerce, by Anderson. The decisions of the English legislature have usually been guided by the principles of these writers.

The commercial system of political economy is very perspicuously explained, and very ably examined in the fourth book of Smith on the Wealth of Nations.

The agricultural system is of comparatively recent origin. It was first brought into vogue by Mons. Quesnai, a celebrated French physician. His ideas were adopted and diffused by several very able writers, and are thought to be most clearly explained in "L'Ordre Natural de Societes Politiques," by Mercier de la Riviére. The writings of Quesnai have been published, with remarks and illustrations in a work entitled "Physiocratie," by Dupont de Nemours. The followers of Quesnai are styled the economists. There is no English writer of celebrity by whom these principles have been adopted in their whole extent; but they are stated, and in some degree controverted, in the last chapter of the fourth book of Smith.

By far the greatest work on political economy is the treatise on "The Wealth of Nations," by Adam Smith. The acuteness of later writers may have discovered some inconsiderable errors in the reasonings; may have shewn that some portions of it are not so completely finished as the rest, and that some well grounded objections may be urged against parts of its arrangement; but the most able judges unanimously regard it as a work at once original, accurate, and profound; as just in its principles, and perspicuous in its illustrations; and as entitling Smith, among other writers on political economy, to the same distinguished rank which among astronomers is held by Newton.

A striking and very important difference between the old and new systems of political economy consists in the former calling upon all occasions for the regulation and controul of laws, and regarding the legislature as best qualified to estimate the value of any particular branches of trade, or modes of conducting business; while by the latter the merchant is supposed to be the best judge of the most eligible method of conducting his own affairs. The former is a system of restrictions and encouragements in which little is left to the choice and sagacity of individuals; in the latter it is supposed that national wealth, which is the aggregate of individual wealth, will increase most rapidly, where, while private property is rendered sacred by the laws, talent and enterprise are under the least possible restraint.

EDDY *tide*, or *Eddy water*, among seamen, is where the water runs back contrary to the tide; or that which hinders the free passage of the stream, and so causes it to return again.

EDDY *wind* is that which returns, or is beat back from a sail, mountain, or any thing that may hinder its passage.

EDGE, in general, denotes the side or border of a thing; but is more particularly used for the sharp side of some weapon, instrument, or tool. Thus we say, the edge of a sword, knife, chissel, &c. In the sea language, a ship is said to edge in with another, when making up to it.

EDGINGS, among gardeners, the series of small but durable plants, set round the edges or borders of flower-beds, &c. The best and most durable plants for this use is box, which, if well planted and rightly managed, will continue in strength and beauty for many years. The seasons for planting these are the autumn, and very early in the spring; and the best species for this purpose is the dwarf Dutch box.

EDICT, in matters of polity, an order or instrument, signed and sealed by a prince, to serve as a law to his subjects. We find frequent mention of the edicts of the Prætor, the ordinances of that officer in the Roman law. In the French law, the edicts are of several kinds; some importing a new law or regulation; others, the erection of new offices, establishments of duties, rents, &c. and sometimes articles of pacification. In France edicts are much the same as a proclamation is with us, but with this difference, that the former have the authority of a law in themselves, from the power which issues them forth; whereas the latter are only declarations of a law, to which they refer, and have no power in themselves.

Edicts can have no room in Britain, because that the enacting of laws is lodged in the Parliament, and not in the King.

Edicts are all sealed with green wax, to shew that they are perpetual and irrevocable.

EDITOR, a person of learning, who has the care of an impression of any work, particularly that of an ancient author. Thus, Erasmus was a great editor; the Louvain doctors, Scaliger, Petavius, F. Sirmond, Bishop Walton, Mr. Hearne, Mr.

Ruddiman, &c. are likewise famous editors.

EDULCORATION, in chemistry, a term applied to the process of washing out from a precipitate any excess of acid or alkali, or compound salt, that may adhere to it. The usual method is by filtration, repeated with different waters, till the last portions that drain are wholly tasteless, and produce no change on the usual tests. This method is tedious, and often ineffectual, and the following adopted in its stead. When the precipitate is deposited, instead of throwing it on a filter, pour it into a silver crucible, and boil it with water; after this, withdraw it from the fire, allow it a a few minutes to subside, and draw off the clear liquor; then add fresh water to the residue, and boil it again, and proceed thus till all the soluble impurities are got rid of.

EEL. See MURÆNA.

EEL *spear*, a forked instrument with three or four jagged teeth, used for catching of eels: that with the four teeth is best, which they strike into the mud at the bottom of the river, and if it strike against any eels, it never fails to bring them up.

EFFECTS, in commerce, law, &c. the goods possessed by any person, whether moveable or immoveable.

EFFERVESCENCE, in chemistry, is a rapid disengagement of gas taking place within a liquid; in consequence of this, numerous bubbles rise to the surface, forming a head of froth, and bursting with a hissing noise. There is some resemblance between effervescence and fermentation; the latter is, however, slower and more durable. Hence chemists formerly applied the term fermentation to all the phenomena which are at present denoted by effervescence. Gas produced by effervescence is by means of single or double elective affinity: in the one case it is generally carbonic acid gas, in the other it is either nitrous gas or hydrogen. Gas can have but little affinity with the fluid in which it is immersed, in order to produce effervescence. Thus, carbonic and muriatic acids are both gasses, and are both extricated from alkaline combinations by sulphuric acid, yet a solution of carbonate of potash in water will produce a vehement effervescence with sulphuric acid, while muriate of potash in the same circumstances will occasion none at all, the carbonic acid having a very slight affinity for water acidulated by sulphuric acid, while the muriatic acid will combine with the same very readily.

EFFLORESCENCE, in chemistry, is the formation of a powdery crust, or of minute crystals, on the surface of any substance. This term is applied to two distinct phenomena. Salts are either unalterable in the air, or they attract moisture from it and are resolved into a fluid, or they yield part of their water of crystallization to the air, and are reduced to powder. This effect, at its commencement, is called efflorescence, and such salts are denominated efflorescent. There is, however, another kind of efflorescence, which is discernible in iron pyrites, or new mortar; and in these cases it implies the appearance of a superficial covering of minute hair-like crystals, and is occasioned by the chemical changes that take place on the surface of the substance where these crystals appear. Thus sulphuret of iron is changed by efflorescence into sulphate of iron or green vitriol; but sulphate of soda, when subjected to the efflorescence first mentioned, though changed in form remains the same in composition, except that it has lost part of its water. The one destroys crystals, the other produces them. See Aikin's "Mineralogical and Chemical Dictionary."

EFFLUVIUM, in physiology, a term much used by philosophers and physicians, to express the minute particles which exhale from most, if not all, terrestrial bodies in form of insensible vapours. Sometimes, indeed, these effluvia become visible, and are seen ascending in form of smoke; constituting what, in animals and plants, makes the matter of perspiration.

Nothing can exceed the subtility of the odoriferous effluvia of plants and other bodies. Mr. Boyle tells us, that having exposed to the open air a certain quantity of asafoetida, he found its weight diminished only the eighth part of a grain in six days: hence, if we suppose, that during all that time a man could smell the asafoetida at the distance of five feet, it will appear that its effluvia cannot exceed the $\frac{1}{26250000000000000}$ part of an inch in magnitude.

The effluvia of mineral substances are called steams; and when collected in mines, or other close places, damps. See GAS.

Malignant effluvia are assigned by physicians, as the cause of the plague, and other contagious diseases; as the jail-distemper, hospital-fever, and the like.

EFT. See LACERTA.

EGGS. The eggs of hens and of birds, in general, are composed of several distinct substances. 1. The shell, or external coating,

which is composed of carbonate of lime .72, phosphate of lime .2, gelatine .3; the remaining .23 are, perhaps, water. 2. A thin, white, and strong membrane, possessing the usual characters of animal substances. 3. The white of the egg, for which see ALBUMEN. 4. The yolk, which appears to consist of an oil of the nature of fat oils, united with a portion of serous matter sufficient to render it diffusible in cold water, in the form of an emulsion, and concrescible by heat. Yolk of egg is used as the medium for rendering resins and oils diffusible in water. An oil of eggs is procured by expression from the yolks of eggs, previously roasted to deprive the serous part of its fluidity. A slight empyreuma is given to the oil by this treatment, which might probably be avoided by applying no greater heat than, on trial, might be found sufficient to coagulate the serum.

The products afforded by the several parts of eggs subjected to destructive distillation, are nearly the same as are obtained by that method from other animal matters.

Mr. Reaumur found that eggs might be preserved during months or years by being covered with mutton-suet, or any other fat substance. And Mr. Parmentier observed that eggs of hens that have had no connection with a cock kept much better than those which are fecundated: he adds too, that they are not inferior in size or flavour, and that the hens lay quite as many; so that those who keep fowls for the sake of eggs alone should have hens only, without any cocks. He recommends the common hen as the most productive, and the black legged as superior to the yellow.

EGYPTIANS. By the laws of England gipsies were formerly subject to imprisonment and forfeiture of goods, but they are now considered chiefly as rogues and vagabonds, and are described as such in the vagrant act. 4 Black. 166.

EHRETIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: berry two-celled; seeds solitary, two-celled; stigma emarginate. There are five species. These are trees or shrubs; the leaves in some are smooth, in others scabrous; the flowers in panicles, terminating, and axillary. E. tinifolia, Tinus-leaved Ehretia, is an upright tree, from twenty to thirty feet in height, with an oblong thick head; branches unarmed, roundish, subdivided; leaves alternate, veined, about four inches long, on short petioles; calyx five-parted, with minute, ovate, segments; corolla a little larger than the calyx, with acute segments finally rolled back; filaments longer than the corolla; style scarcely shorter than the stamens, oval-shaped, bifid; stigmas simple; berry spherical. This plant is a native of Cuba and Jamaica; flowering in February.

EHRHARTA, in botany, a genus of the Hexandria Monogynia class and order. Essential character: calyx a two-valved, one-flowered glume; corolla double, each two-valved; the outer compressed. There are five species, of which E. cartilaginea is a very beautiful smooth grass; it has a perennial fibrous root; culms erect, jointed, about two feet high; leaves sheathing, the lower ones a hand in length, the upper ones much shorter; disk smooth; edge cartilaginous and crenate; panicle oblong, consisting of fifteen or twenty flowers; peduncles capillary, loose, flexuose, in threes, pairs, or solitary, simple, or sometimes a little branched, growing thicker at the top; nectary and filaments white; anthers yellow. This plant was first observed at the Cape by Thunberg.

EIDER *down*. See DOWN.

EIGNE, the eldest, or first born.

EIRE *or* EYNE, signifies the court of justice itinerant. Eyer is also taken to signify the justice seat. See JUSTICES *in eyne*.

EJECTMENT, is a mixed action, by which originally a lessee for years, when ousted, recovered his term and damages. It is a real action in respect of the lands, but personal in respect of the damages. Since the disuse of real action it is become the common method of trying the title to lands or tenements.

The modern method of proceeding in ejectment entirely depends on a string of legal fictions; no actual lease is made; no actual entry by the plaintiff; no actual ouster by the defendant; but all are merely ideal for the purpose of trying the title. To this end a lease for a term of years is stated in the proceedings, to have been made by him who claims title to the plaintiff, who is generally a fictitious person; though it ought to be a real person to answer for the defendant's costs. In this proceeding, which is the declaration (for there is no other process in this action), it is also stated, that the lessee, in consequence of the demise to him made, entered into the premises; and that the defendant, who is also now another fictitious person, and who is called the casual ejector, afterwards enters

ed thereon and ousted the plaintiff; for which ouster the plaintiff brings this action. Under this declaration is a notice, supposed to be written by this casual ejector, directed to the tenant in possession of the premises; in which notice the casual ejector informs the tenant of the action brought by the lessee, and assures him, that as he, the casual ejector, has no title to the premises, he shall make no defence, and therefore he advises the tenant to appear in court, at a certain time, and defend his own title; otherwise he, the casual ejector, will suffer judgment to be had against him, by which the actual tenant will inevitably be turned out of possession.

The ancient way of proceeding was by actually sealing a lease on the premises, by the party interested who was to try the titles; and this method is still in use in several cases.

First, where the house or thing for which ejectment is brought is empty.

Secondly, when a corporation is lessor of the plaintiff, they must give a letter of attorney to some person to enter and seal a lease on the land; for a corporation cannot make an attorney, or a bailiff, except by deed, nor can they appear but by making a proper person their attorney by deed; therefore they cannot enter and demise upon the land as natural persons can.

Thirdly, when the several interests of the lessors of the plaintiff are not known, for in that case it is proper to seal a lease on the premises, lest they should fail in setting out in their declaration the several interests which each man possesses.

Fourthly, where the proceedings are in an inferior court they must proceed by actually sealing a lease, because they cannot make rules, confess lease, entry, and ouster; inasmuch as inferior courts have not authority to imprisonment for disobedience to their rules. It is a general rule that no person can in any case bring an ejectment, unless he have in himself, at the time, a right of entry; for although, by the modern practice, the defendant is obliged by rule of court to confess lease, entry, and ouster; yet that rule was only designed to expedite the trial of the plaintiff's right, and not to give him a right which he had not before.

The damages recovered in these actions, though formerly their only intent, are now usually very small and inadequate, amounting to one shilling, or some other trifling sum. In order therefore to complete the remedy, when the possession has been long detained from him that has right, an action of trespass also lies, after a recovery in ejectment, to recover the mesne profits which the tenant in possession had wrongfully received; which action may be brought in the name of either the nominal plaintiff in the ejectment, or his lessor, against the tenant in possession, whether he be made party to the ejectment, or suffer judgment to go by default. An ejectment cannot be brought after the lessor of the plaintiff, or his ancestor, has been out of possession 20 years. See Limitation.

EKEBERGIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Trihilatæ. Meliæ, Jussieu. Essential character: calyx four-parted; petals four; nectary like a garland, surrounding the germ; berry containing five oblong seeds. There is but one species, *viz.* E. capensis, a tree with abruptly, or unequally pinnate leaves; the common petiole flatted; the flowers panicled and axillary.

ELÆAGNUS, in botany, English *oleaster*, a genus of the Tetrandria Monogynia class and order. Natural order of Elæagni, Jussieu. Essential character: corolla, none; calyx four-cleft, bell-form, superior; drupe below the calyx. There are nine species.

ELÆIS, in botany, a genus of the Apendix Palmæ. Natural order of Palms. Essential character: male, calyx six-leaved; corolla six-cleft; stamens six. Female, calyx six-leaved; corolla six-petalled; stigmas three; drupe fibrous; nut one to three valved. There is but one species; *viz.* E. guineensis. It is called in the West Indies the oily palm. The fruit of this tree was first carried from Africa to America by the negroes. It grows in great plenty on the coast of Guinea, and also in the Cape de Verd islands.

From this fruit the inhabitants of the West India islands draw an oil, in the same manner as it is extracted from olives. They also extract a liquor from the body of the tree, which when fermented has a vinous quality, and will inebriate. The leaves are wrought by the negroes into mats, on which they repose.

ELÆOCARPUS, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled, jagged; anthers two-valved at the tip; drupe with a curled shell. There are six species, mostly natives of the East Indies.

ELÆODENDRUM, in botany, *olive wood*, a genus of the Pentandria Monogynia

class and order. Essential character; corolla five-petalled: drupe ovate, with a two-celled nut. There are two species, of which E, orientale is a moderate-sized twiggy shrub, or tree, a native of the oriental regions: leaves ovate lanceolate, smooth, slightly waved, sometimes inclining to a subserrated appearance on the upper parts of the shoots; flowers borne towards the ends of the branches, of a pale green colour, supported on shortish pedicles, each of which springs from a longer common pedicle.

ELASTICITY, that disposition in bodies by which they endeavour to restore themselves to the posture from whence they were displaced by any external force. The principal phenomena observable in elastic bodies are: 1. That an elastic body (*i. e.* a body perfectly elastic, if any such there be) endeavours to restore itself with the same force with which it is pressed or bent. 2. An elastic body exerts its force equally towards all sides; though the effect is chiefly found on that side where the resistance is weakest, as is evident in the case of a gun exploding a ball, a bow-shooting out an arrow, &c. 3. Elastic bodies, in what manner soever struck, or impelled, are inflected, and rebound after the same manner: thus a bell yields the same musical sound, in what manner or on what side soever it be struck; the same of a tense or musical chord; and a body rebounds from a plane in the same angle in which it meets or strikes it, making the angle of incidence equal to the angle of reflection, whether the intensity of the stroke be greater or less. 4. A body perfectly fluid, if any such there be, cannot be elastic, if it be allowed that its parts cannot be compressed. 5. A body perfectly solid, if any such there be, cannot be elastic; because, having no pores, it is incapable of being compressed. 6. The elastic properties of bodies seem to differ, according to their greater or less density or compactness, though not in an equal degree: thus, metals are rendered more compact and elastic by being hammered: tempered steel is much more elastic than soft steel; and the density of the former is to that of the latter as 7809 to 7738: cold condenses solid bodies, and renders them more elastic; whilst heat, that relaxes them, has the opposite effect: but, on the contrary, air, and other elastic fluids, are expanded by heat, and rendered more elastic.

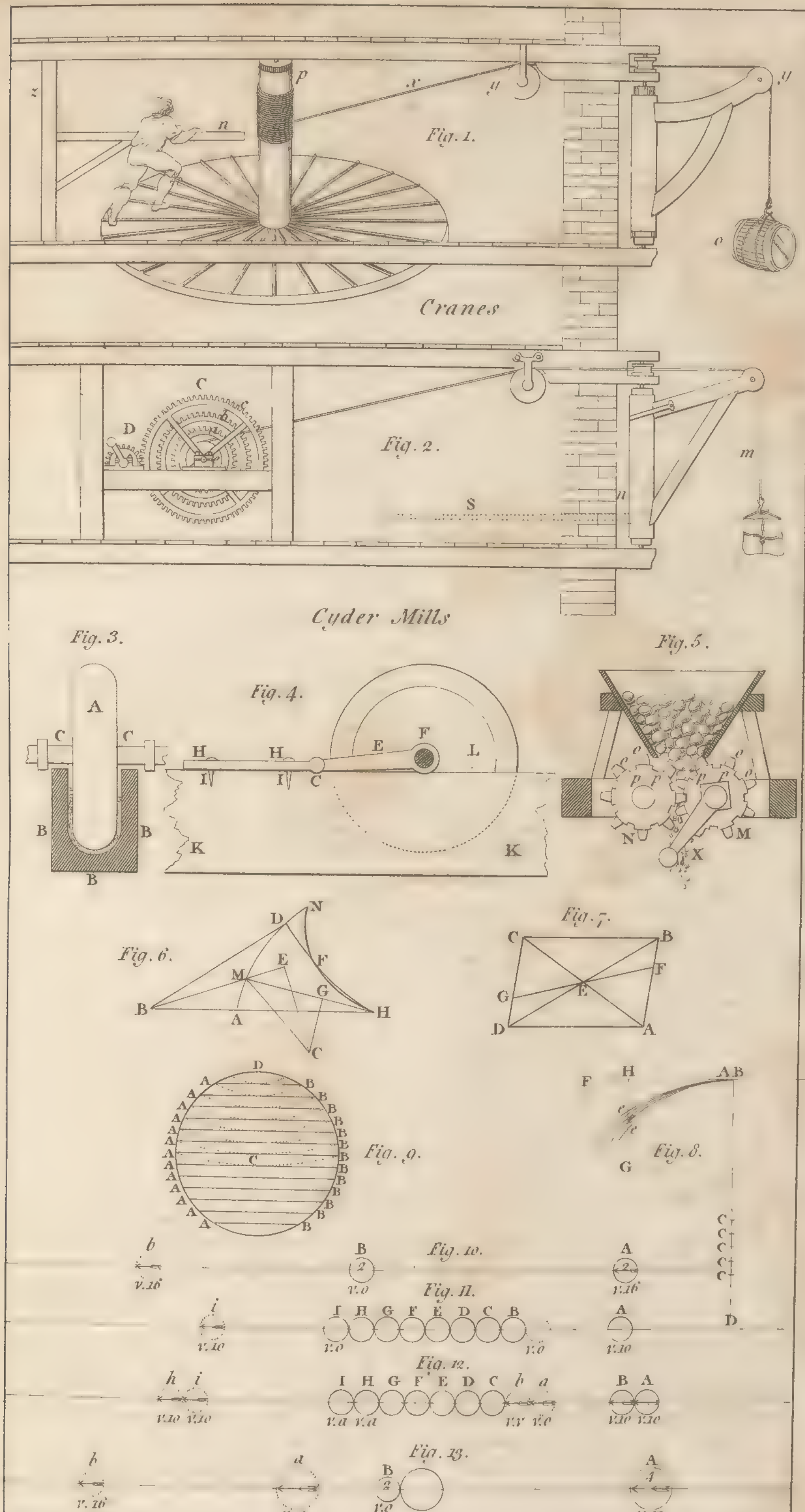
Some philosophers account for elasticity from the principles of corpuscular attraction and repulsion: thus, if a steel spring, wire, or piece of very thin glass, be bent out of its natural position, the particles on the convex part are forced from the intimate union they had before; and, on the concave part, they are forced nearer together, or harder upon each other, than in the natural state: in both which cases there will be a considerable resistance to overcome, and consequently require a superior force. During this state of the particles, they may be said to be under a sort of tension on one side, and compression on the other; and since by this force they are not drawn out of each others attraction, as soon as the force is remitted or ceases to act, the attractive power reduces the particles, and unbends the wire. Now it is well known, that many substances are composed of such fibrous parts or filaments which resemble fine wires, and are interwoven and disposed in such a manner, as in sponge, for instance, that they cannot be compressed without being bent or wrested from their natural position; whence all bodies will in such cases exert a spring or force to restore themselves in the same manner that the bent wire did. Others attribute the elasticity of all hard bodies to the force of the air included within them: and so they make the elastic force of the air the principle of elasticity in all other bodies. See PNEUMATICS.

All substances that we know of are in some degree or other elastic, but none of them perfectly so; such are most metals, semimetals, stones, and animal and vegetable substances, however they may differ in degree.

We may consider all elastic bodies to be made up of such strings or fibres as A B (Plate IV. Miscel. fig. 9.) or rather of elastic strata parallel to each other, represented by A B in the ball D C. If this ball be struck at D by a hard or elastic body, all the strata will be bent in towards C, as expressed by the dotted lines, whilst the ball is flattened or dented at D. But the strata quickly restoring themselves, the surface of the ball re-assumes its first figure, and that more or less exactly, according as the elasticity is more or less perfect.

The great law of perfectly elastic bodies, is, that their relative velocity will remain the same before and after collision; that is, perfectly elastic bodies will recede from one another after the stroke with the same velocity that they came together. Many curious phænomena may be explained from this property in bodies.

If the ivory ball A, (fig. 10.) weighing two ounces, strike with the velocity 16 against



J. Farey Junr. del. Lowry sculp.

London, Published by Longman, Hurst Rees & Orme, Octr. 1. 1808.

B at rest, weighing also two ounces, the body B will move forward after the stroke with the velocity 16, A remaining at rest in its place. The reason of this is, that the body A loses one half of its motion by striking the equal body B, and the other half by the elasticity of B, recovering its former figure. From this experiment, several curious phenomena arise: thus, if a row of shovel-board pieces (that is, metalline cylinders of about half an inch in height, and two inches diameter) be laid upon a smooth table, and you take a single piece, and drive it against the row, the last piece of the row will fly off; for if A (fig. 11.) strike the row of pieces B, C, D, E, F, G, H, I, in the direction A *a*, then will the last piece I fly off to *i* with the same velocity that A struck B: and whatever be the velocity of A, no other piece but the last piece I will fly off. But if you take two pieces, as A and B, (fig. 12.) and strike them together against the row C, D, E, F, G, H, I, the two last pieces, H and I, will fly off from the other end of the row with the same velocity that A and B made the stroke.

If three or more pieces are made use of to make the stroke, the very same number will fly off from the other end of the row; and, it is to be observed, that the same will happen with equal elastic balls, suspended in a row by strings of the same length.

Again, if the elastic body A, (fig. 13.) weighing four ounces, strike the quiescent body B, weighing only two ounces, with a velocity equal to 12; then will the velocity of A, after the stroke, be 4, and that of B 16. Just the reverse of this happens when a lesser body strikes against the greater; in which case, the striking, or lesser body, will be reflected with one-fourth of its first motion, and the greater be carried forward with a motion which is as 16.

The magnitude and motions of spherical bodies perfectly elastic, and moving in the same right line, and meeting each other, being given, their motion after reflection may be determined thus: let the bodies be called A and B, and the respective velocities a and b; then, if the bodies tend the same way, and A, moving swifter than B, follows it, the velocity of the body A, after the reflection, will be $\frac{a\mathrm{A}-a\mathrm{B}+2b\mathrm{B}}{\mathrm{A}+\mathrm{B}}$, and that of the body $\mathrm{B}=\frac{2a\mathrm{A}-b\mathrm{A}+b\mathrm{B}}{\mathrm{A}+\mathrm{B}}$; but if the bodies meet, then changing the sine of b, the velocity of A will be $\frac{a\mathrm{A}-a\mathrm{B}-2b\mathrm{B}}{\mathrm{A}+\mathrm{B}}$, and that of $\mathrm{B}=\frac{2a\mathrm{A}+b\mathrm{A}-b\mathrm{B}}{\mathrm{A}+\mathrm{B}}$: and if either of these happen to come out negative, the motion after the stroke tends the contrary way to that of A before it; which is also to be understood of the motion of the body A in the first case.

ELATE, in botany, a genus of the Apendix Palmæ. Natural order of Palms. Essential character: male, calyx three-toothed; corolla three-petalled; anthers six, sessile. Female, calyx one-leafed; corolla three-petalled; pistils one; stigmas three; drupe one-seeded. There is but one species, *viz.* E. sylvestris, prickly leaved elate. This palm grows to the height of fourteen feet, covered with an ash-coloured crust, closely united with a hard whitish wood; pinnate leaves break out from the top of the trunk only, in a decussated order; the old ones dropping off as the young ones break forth. The flowers are concealed in stiff, green, coriaceous spathes, they are small, several on the same peduncle; petals whitish green; they have no smell, but a rough taste. The fruit is like a wild plum, with a hard woody point at top, covered with the calyx at bottom. The nut or stone is oblong, marked longitudinally with a deep furrow, containing a bitter kernel. The poorer sort of people chew the nut in the same manner as the areca nut, with the leaf of the betel and quicklime. The elephants are very fond of the fruit branches, which are sweet. It is a native of the East Indies.

ELATER, in natural history, a genus of insects of the order Coleoptera: antennæ filiform, lodged in a groove under the head and thorax: underside of the thorax terminating in an elastic spine, placed in a cavity of the abdomen; by which means the body, when placed on the back, springs up and recovers its natural posture. This genus, which is extremely numerous, is divided into two sections, *viz.* A. feelers hatchet-shaped; and B. feelers clavate, the club round. Of the latter only three species are mentioned, but of the former two hundred at least have been enumerated. In point of size the European species are not comparable to those which are natives of the tropical regions. Among the most remarkable may be mentioned E. flabellicornis, which is more than two inches long, and is a native of India, and of many parts of Africa. E. noctilucus, found in South America, and called there cocujas, is not so large as the last, but the spots on the tho-

tax like those on the abdomen of the glow-worm are highly luminous, diffusing through the night a brilliant splendour, by which the smallest print may be read, and eight or ten of them in a phial will afford a light equal to that of a common candle. Many species of the elater are natives of our own country ; but they are seldom distinguished by any brilliancy of colour, and are far inferior in size to the exotic ones. E. tesselatus, so called from the manner in which it is marked, is not uncommon in the fields during the middle of summer. The larvæ of these insects are of a slender form, and devour the roots of the grasses. That insect, so destructive to newly sown French beans, the wire-worm, is thought to be the larvæ of the E. obscurus.

ELATERIUM, in botany, a genus of the Monoecia Monandria class and order. Natural order of Cucurbitaceæ. Essential character : male, calyx none; corolla salver-shaped. Female, calyx none ; corolla salver-shaped ; capsule inferior, one-celled, two-valved. There are two species.

ELATINE, in botany, a genus of the Octandria Tetragynia class and order. Natural order of Inundatæ. Caryophyllæ, Jussieu. Essential character : calyx four-leaved ; petals four ; capsule four-celled, four-valved, flatted. There are two species. These are annual aquatic herbs, very low and spreading; the flowers axillary and small.

ELDERS, among the Jews, were persons of great age, experience, and wisdom : the denomination is known in the Presbyterian discipline. They are officers who, with the ministers and deacons, compose the sessions of the kirk. The elder's business is to assist the minister in visiting the congregation upon occasion, to watch over the morals of the people of his district, and to give them private reproof in case of any disorder; but if the scandal be gross, or the person obstinate, he lays the thing before the session. The elders are chosen from among the most substantial, knowing, and regular people, by the session or consistory of the kirk. There is a ruling elder in every session: he should be a man of spotless character, and of principal consideration and interest in his parish ; he is chosen out of the kirk session : the congregation is to approve of the choice : the minister ordains him before the congregation : he may be chosen to assist in any church judicatory, and in all manner of government and discipline, has an equal vote with the minister.

ELECTION, in law, is where a person has a choice of one or more things which happen upon several occasions; as where he has by law two remedies, and must take only one : thus, a creditor, in cases of bankruptcy, may either prove his debt under the commission, or proceed at law ; but in this case he is compelled to make his election: where also a person having obtained a judgment, is entitled to execution, he may either take his remedy against the goods or the person of his debtor ; but if he proved against the person in the first instance, he cannot afterwards have recourse to the goods; but if he take the goods, and these should be found inadequate to his demand, he may afterwards take the body.

ELECTION *of bishops*. See BISHOPS.

ELECTION *of ecclesiastical persons.* If any person, having a voice, take any reward for an election in any church, college, school, &c. it shall be void ; and if any such societies resign their places to others for reward, they incur a forfeiture of double the sum ; and the party giving, and the party taking it, are thereby rendered incapable of such place. 31 Eliz. c. 6. See BISHOPS.

ELECTION *of members of parliament.* Qualification of the candidates. A member cannot sit in parliament until twenty-one years of age ; and must not be alien born ; nor one of the twelve judges, who sit in the lords, as attendants upon the house ; but persons who have judicial places in the other courts, ecclesiastical or civil, are eligible ; the clergy are not eligible, because they might sit in the convocation ; nor persons attainted of treason or felony.

By the 30 Charles II. st. 2. c. 1, and 1 Geo. I. c. 13, in order to prevent papists from sitting in either house of parliament, no person shall sit or vote in either house till he hath, in the presence of the house, taken the oaths of allegiance, supremacy, and abjuration ; sheriffs of counties, and mayors and bailiffs of boroughs, are not eligible in their respective jurisdictions, as being returning officers ; but a sheriff of one county may be chosen knight of another.

By several statutes, no persons concerned in the management of any duties or taxes, created since 1692, except the commissioners of the treasury ; nor any of the officers following, *viz.* commissioners of prizes, transports, sick and wounded, wine licenses, navy and victualling; secretaries or receivers of prizes ; comptrollers of the army accounts; agents for regiments ; go-

vernors of plantations; officers of Minorca or Gibraltar; officers of the excise and customs; clerks or deputies in the several offices of the treasury, exchequer, navy, victualling, admiralty, pay of the army or navy; secretaries of state, salt, stamps, appeals, wine-licenses, hackney-coaches, hawkers and pedlars; nor any persons that hold any new office under the crown, created since 1705, are capable of being elected. But this shall not extend to, or exclude the treasurer or comptroller of the navy; secretaries of the treasury; secretary to the chancellor of the exchequer; secretaries of the admiralty; under secretary of state; deputy paymaster of the army; or any person holding any office for life, or so long as he shall behave himself well in his office. 15 Geo. II. c. 22.

By 6 Anne, c. 7. s. 26, any member accepting an office of profit under the crown, except an officer of the army or navy, accepting a new commission, his election shall be void; but he may be re-elected. Persons having pensions from the crown during pleasure, are incapable of being elected. 6 Anne c. 7. s. 25.

By the 22 Geo. III. c. 45, no contractor with the officers of government, or with any other person for the service of the public, shall be elected, or sit in the house, as long as he holds any such contract, or derives any benefit from it; but this does not extend to contracts with corporations, or with companies, which then consisted of ten partners; or to any person to whom the interest of such a contract shall accrue by marriage or operation of law, for the first twelve months; and if any person disqualified by such a contract shall sit in the house, he shall forfeit 500*l.* for every day; and if any person who engages in a contract with government, admit any member of parliament to a share of it, he shall forfeit 500*l.* to the prosecutor. No person shall sit or vote in the House of Commons for a county, unless he has an estate, freehold or copyhold, for his life; or some greater estate, of the clear yearly value of 600*l.*; nor for a city or borough, unless he have a like estate of 300*l.*; and any other candidate, or two electors, may require him to make oath thereof at the time of election, or before the day of the meeting of parliament; and before he shall vote in the House of Commons, he shall deliver in an account of his qualification, and the value thereof under his hand, and make oath of the truth of the same; but this shall not extend to the eldest son or heir apparent of a peer, or of any person qualified to serve as knight of a shire, nor to the members of either of the two universities. 9 Anne c. 5. 33 Geo. II. c. 20. Qualifications of electors. No person shall be admitted to vote under the age of twenty-one years: this extends to all members, as well for boroughs as counties. 7 and 8 Will. c. 25.

Every elector of a knight of a shire shall have freehold to the value of 40*s.* a year within the county, which is to be clear of all charges and deductions, except parliamentary and parochial taxes. No person shall vote in right of any freehold granted fraudulently, to qualify him to vote; and every person who shall prepare or execute such conveyance, or shall give his vote under it, shall forfeit 40*l.* 10 Anne, c. 25. No person shall vote for a knight of the shire, without having been in the actual possession of the estate for which he votes, or in the receipt of the rents or profits to his own use, above twelve calendar months, unless it come to him by descent, marriage, marriage-settlement, devise, or promotion to a benefice or office. 18 Geo. II. c. 1. No person convicted of perjury shall be capable of voting at an election. No person shall vote in respect of an annuity or rent-charge, unless registered with the clerk of the peace twelve calendar months before; such annuity or rent-charge must issue out of freehold estate. No person shall vote for a knight of a shire, in respect of any messuages, lands, or tenements, which have not been charged to the land-tax six calendar months before. 20 Geo. III. c. 17. No person shall vote for any estate holden by copy of court-roll. 31 Geo. II. c. 14.

In mortgaged, or trust-estates, the mortgagor, or *cestuy que* trust, shall vote, and not the trustee or mortgagee, unless they be in actual possession. All conveyances to multiply voices, or to split votes, shall be void; and no more than one voice shall be admitted for one and the same house or tenement.

The right of election in boroughs is various, depending entirely on the several charters, customs, and constitutions of the respective places. By 2 Geo. II. c. 24, this right of voting, for the future, shall be allowed according to the last determination of the House of Commons concerning it.

And no person, claiming to vote in right of his being a freeman of a corporation (other than such as claim by birth, marriage, or servitude) shall be allowed, unless

he have been admitted to his freedom twelve calendar months before 3 Geo. III. c. 15. All undue influence whatever upon the electors is illegal, and strongly prohibited. As soon as the time and place of election within counties or boroughs are fixed, all soldiers quartered in the place are to remove, at least one day before the election, to the distance of two miles or more, and not to return till one day after the poll be ended; except in the liberty of Westminster, or other residence of the royal family, in respect of his Majesty's guards, and in fortified places. 8 Geo. II. c. 30. By the 7th and 8th Wil. c. 4, to prevent bribery and corruption, no candidate, after teste of the writ of summons, or after a place becomes vacant in parliament time, shall, by himself, or by any other ways or means on his behalf, or at his charge, before his election, directly or indirectly give, or promise to give, to any elector any money, meat, drink, provision, present, reward, or entertainment, to or for any such elector in particular, or to any county, city, town, borough, port, or place in general, in order to his being elected, on pain of being incapacitated. To guard still more against gross and flagrant acts of bribery, it is enacted by 2 Geo. II. c. 24, explained and enlarged by 9 Geo. II. c. 38, and 16 Geo. III. c. 11, that if any money, gift, office, employment, or reward, be given, or promised to be given, to any voter at any time in order to influence him to give or withhold his vote, as well he that takes, as he that offers such a bribe, forfeits 500*l.* and is for ever disabled from voting and holding any office in any corporation, unless, before conviction, he will discover some other offender of the same kind, and then he is indemnified for his own offence.

If the election shall not be determined upon view, with consent of the freeholders there present, but a poll shall be demanded, the same shall commence on the day on which such demand is made, or on the next day at farthest (if it be not Sunday, and then on the day after) and shall be proceeded in from day to day (Sundays excepted) until finished, and shall not continue more than fifteen days (Sundays excepted); and the poll shall be kept open seven hours at least each day, between eight in the morning and eight in the evening, 25 Geo. III. c. 84. The sheriff shall allow a cheque-book for every poll-book for each candidate, to be kept by their inspectors at the place of taking the poll, 19 Geo. II. c. 28. By the 34 Geo. III. c. 73, in order to expedite the business at elections, the returning officers are enabled, on request of the candidates, to appoint persons to administer to voters the oaths of allegiance, supremacy, the declaration of fidelity, the oath of abjuration, and the declaration or affirmation of the effect thereof, previously to their coming to vote; and to grant the voters certificates of their having taken the said oath; without which certificate they shall not be permitted to vote if they are required to take the oaths.

Every freeholder, before he shall be admitted to poll for a knight of the shire, shall, if required by a candidate or any elector, make oath of his qualification to vote; in which case the sheriff and clerks shall enter the place of his freehold, and the place of his abode, as he shall disclose the same at the time of giving his vote; and shall enter *jurat* against the name of every such voter who shall have taken the oath, 10 Anne c. 23. s. 5. After the election, the names of the persons chosen shall be written in an indenture, under the seals of the electors, and tacked to the writ.

The election being closed, the returning officer in boroughs, returns his precept to the sheriff, with the persons elected by the majority. And the sheriff returns the whole, together with the writ for the county, and the names of the knights elected thereupon, to the clerk of the crown in Chancery, before the day of meeting, if it be a new parliament; or within fourteen days after the election, if it be an occasional vacancy; and this under the penalty of 500*l.* If the sheriff do not return such knights only as are duly elected, he forfeits by stat. Henry VI. 100*l.* and the returning officer of a borough for a like false return 40*l.* and by the late statutes they are liable to an action at the suit of the party duly elected, and to pay double damages, and the like remedy shall be against an officer making a double return. If two or more sets of electors make each a return of a different member (which is called a double election) that return only, which is signed and sealed by the returning officer to whom the sheriff's precept was directed, is good; and the members by him returned shall sit, until displaced on petition. On petition to the House of Commons, complaining of an undue election, forty-nine members shall be chosen by ballot, out of whom each party shall alternately strike

out one, till they are reduced to thirteen, who, together with two more, of whom each party shall nominate one, and who are called the nominees, shall be a select committee for determining such controverted election, 10 and 11 Geo. III. c. 16 and 42. See PARLIAMENT.

ELECTION, is a term frequently used in mathematics, to signify the several different ways of taking any number of things proposed, either separately, or as combined in pairs, in threes, in fours, &c.; not as to the order, but only as to the number and variety of them. Thus, of the things *a*, *b*, *c*, *d*, &c. the elections of

$$\left.\begin{array}{l}\text{One thing}\\ \text{Two things}\\ \text{Three things}\end{array}\right\}\text{are}\left\{\begin{array}{l}(a)\ 1=2^1-1\\ a,\ b,\ ab)\ 3=2^2-1\\ (a,\ b,\ c,\ ab,\ ac,\ bc,\ abc)\ 7=2^3-1\end{array}\right.$$

And generally of any number n, all the elections are 2^n-1; that is, one less than the power of 2, whose exponent is n; the number of single things to be chosen either separately, or in combinations: thus, when $n=12$, the answer is $2^{12}-1=4096-1=4095$.

ELECTIVE *attraction*. The attractions which take place in the chemical operations of art and nature, are, for the most part, effected under circumstances of such complexity, that it is extremely difficult to deduce the general laws by which they are governed, or even the particular habitudes of the bodies so acted upon. In general it appears to us, from the facts, that some among the bodies upon which we make our experiments are attracted by each other, and enter into combination, while others seem to have no disposition to form this union, (see CHEMISTRY) and from this principal observation the attractions of chemistry have been called elective attraction, or elective affinities. See ATTRACTION.

The phenomena of attraction, as distinguished under the heads of simple elective attraction, and double or more complex elective attraction, have been sketched under our article CHEMISTRY. It is clear, that no results of this nature can be foretold, or indicated, unless the order and energy of the powers of bodies upon each other be first known. Geoffroy, in his table of simple elective attractions, first led the way in this research; and he was followed by Bergman, who greatly improved both the tables and the method of philosophising, in his treatise on the elective attractions; and, lastly, that most perspicuous chemist, Berthollet, has pursued the subject to a much greater extent, in his "Statique Chimique," of which we have an indifferent translation by Lambert.

We have, at the article last quoted, made mention of the variations in results of combination arising from the proportion of the principles, the influence of solvents, of cohesion, of elasticity, of efflorescence, and from the compounded nature of the principles themselves, the state of saturation, the effect of heat, &c. These variable considerations must necessarily render all tables of the effects of attraction inapplicable, excepting with allowances; but they may nevertheless be considered as exhibiting very valuable summaries of facts. A like uncertainty must be considered as belonging to all numerical or other inferences, of the relative energies of the elective attractions; for determining which, it must be confessed, our means are far from being adequate, even if we were fully acquainted with the disturbances to which it is probable they are subject from the Galvanic action. See GALVANISM.

Tables I. to VI. contain in substance the two tables of Attractiones Electivæ Simplices, placed at the end of Bergman's treatise upon elective attractions, with such corrections and additions as subsequent discoveries have rendered necessary. These tables require no other explanation, than that the substances enumerated are considered to be simple, as far as relates to the facts exhibited in these sketches. The order of position denotes that the higher any substance stands in any column, the stronger is its elective attraction to the substance at the head of that column. The under part of each table exhibits the attractions in the dry way, and must be considered as entirely distinct from the upper part.

TABLE I. SIMPLE ELECTIVE ATTRACTIONS.

ACIDS.

IN THE HUMID WAY.

Sulphuric Acid.	Sulphurous Acid.	Nitric Acid.	Boracic Acid.	Succinic Acid.	Acetous Acid.
Barytes Strontian Potash Soda Lime Magnesia Ammonia Glucine Yttria Alumine Zircon Metallic oxides Water Alcohol	Barytes Lime Potash Soda Strontian Magnesia Ammonia Glucine Alumine Zircon Metallic oxides	Potash Soda Barytes Strontian Lime Magnesia Glucine Yttria Alumine Zircon Metallic oxides Water Alcohol	Lime Barytes Strontian Magnesia Potash Soda Ammonia Glucine Alumine Zircon Metallic oxides Water Alcohol	Barytes Lime Potash Soda Ammonia Magnesia Alumine Metallic oxides Water Alcohol	Barytes Potash Soda Strontian? Lime Ammonia Magnesia Metallic oxides Glucine Alumine Zircon Water Alcohol
	N. B. The carbonic acid follows the same order in the humid way.	N. B. The muriatic, oxy-muriatic, and nitro-muriatic follow the same order.	N. B. The oxalic, tartarous, sebacic, phosphoric, & arsenic follow the same order: so do the fluoric and tungstic, substituting silex for metallic oxides.	N. B. The citric and benzoic follow the same order, except that lime should come before barytes, and for the citric Zircon should be added after alumine.	

IN THE DRY WAY.

Sulphuric Acid.	Sulphurous Acid.	Nitric Acid.	Boracic Acid.
Potash Soda Barytes Strontian Lime Magnesia Zircon Metallic oxides Ammonia Alumine		Barytes Strontian Potash Soda Lime Magnesia Metallic oxides Ammonia Alumine	Lime Barytes Strontian Magnesia Potash Soda Metallic oxides Ammonia Alumine
		N. B. The muriatic, oxy-muriatic, nitro-muriatic, and acetous, follow the same order in the dry way.	N. B. The fluoric, benzoic, sebacic, phosphoric, and arsenic, follow the same order in the dry way.

Camphoric Acid.
Lime Potash Soda Barytes Ammonia Alumine Magnesia

Prussic Acid.	Molybdic Acid.
Potash Soda Ammonia Lime Barytes Strontian Magnesia Alumine Metallic oxides Water Alcohol	Sulphur? Potash Soda The earths Metallic oxides

Chromic Acid.
Fixed alkalies Oxide of lead Oxide of copper

TABLE II.—SIMPLE ELECTIVE ATTRACTIONS.

ALKALIES AND EARTHS.

IN THE HUMID WAY.

Potash.	Barytes.	Strontian.	Lime.	Magnesia.	Alumine.	Silex.
Acids, sulphuric	Acids, sulphuric	Acids, sulphuric	Acids, oxalic	Acids, oxalic	Acids, sulphuric	Fluoric acid
nitric	oxalic	phosphoric	sulphuric	phosphoric	nitric	Potash
muriatic	succinic	oxalic	tartarous	sulphuric	muriatic	Soda
sebacic	fluoric	tartarous	succinic	fluoric	oxalic	Barytes
fluoric	phosphoric	fluoric	phosphoric	sebacic	arsenic	Strontian
phosphoric	mucous	nitric	mucous	arsenic	fluoric	
oxalic	molybdic	muriatic	nitric	mucous	tartarous	
tartarous	nitric	succinic	muriatic	succinic	succinic	
arsenic	muriatic	acetous	sebacic	nitric	mucous	
succinic	sebacic	arsenic	suberic	muriatic	citric	
citric	suberic	boracic	fluoric	tartarous	phosphoric	
benzoic	citric	carbonic	arsenic	citric	benzoic	
acetous	tartarous	Water	citric	malic	acetous	
mucous	arsenic	Fat oils	malic	benzoic	boracic	
boracic	benzoic	Sulphur	benzoic	acetous	sulphurous	
sulphurous	acetous	Sulphuretted hydrogen.	acetous	boracic	nitrous	
nitrous	boracic		boracic	sulphurous	carbonic	
carbonic	sulphurous		sulphurous	nitrous	prussic	
prussic	nitrous		nitrous	carbonic		
Water	carbonic		molybdic	prussic		
Fat oils	prussic		carbonic	Sulphur		
Sulphur	Water		lithic			
Metallic oxides	Fat oils		prussic			
Soda and ammonia follow the same order both in the humid and dry way, except that with ammonia the sulphuric acid comes first in both.	Sulphur		Water			
	Sulphuretted hydrogen		Fat oils			
	Phosphorus		Sulphur			
			Phosphorus			

(*The DRY WAY on next page.*)

TABLE II. (CONTINUED.)

CONTINUATION OF TABLE II.

IN THE DRY WAY.

Potash.	Barytes.	Strontian.	Lime.	Magnesia.	Alumine.	Silex.
Acids, phosphoric boracic arsenic sulphuric nitric muriatic sebacic fluoric succinic benzoic acetous Barytes Lime Magnesia Alumine Silex Sulphur	Acids, phosphoric boracic arsenic sulphuric nitric muriatic fluoric sebacic succinic benzoic acetous Fixed alkalies Sulphur Oxide of lead		As barytes	As barytes	As barytes	Potash Soda Phosphoric acid Oxide of lead

TABLE III. SIMPLE ELECTIVE ATTRACTIONS.

WATER AND COMBUSTIBLE SUBSTANCES.

IN THE HUMID WAY.

Water.	Sulphur.	Saline Sulphurets.	Alcohol.	Ether.
Potash	Oxygen	Oxygen	Water	Alcohol
Soda	Molybdic oxide and acid	Oxide of gold	Ether	Volatile oils
Ammonia	Oxide of lead	silver	Volatile oils	Water
Deliquescent salts	tin	mercury	Ammonia	Sulphur
Alcohol	silver	arsenic	Fixed alkali	
Carbonat of ammonia	mercury	antimony	Alkaline sulphurets	
Ether	arsenic	bismuth	Sulphur	
Sulphuric acid	antimony	copper	Muriats	
Non-deliquescent salts	iron	tin	Phosphoric acid	
	Potash	lead		
	Soda	nickel		
	Barytes	cobalt		
	Strontian	manganese		
	Lime	iron		
	Magnesia	Other metallic oxides		
	Phosphorus	Carbon		
	Fat oils	Water		
	Ammonia	Alcohol		
	Ether	Ether		
	Hydrogen?			

Fat Oils.	Volatile Oils.
Barytes?	Ether
Strontian?	Alcohol
Lime	Fat oils
Metallic oxides	Fixed alkalies
Ether	Sulphur
Volatile oils	Phosphorus
Fixed alkalies	
Ammonia	
Sulphur	
Phosphorus	

IN THE DRY WAY.

Oxygen	Manganese
Potash	Iron
Soda	Copper
Iron	Tin
Copper	Lead
Tin	Silver
Lead	Gold
Silver	Antimony
Cobalt	Cobalt
Nickel	Nickel
Bismuth	Bismuth
Antimony	Mercury
Mercury	Arsenic
Arsenic	Carbon?
Uranium?	
Molybdena	
Tillurium	

TABLE IV. SIMPLE ELECTIVE ATTRACTIONS.

OXYGEN AND METALS.

IN THE HUMID WAY.

Oxygen.	Oxide of Gold.	Oxide of Silver.	Oxide of Platina.	Oxide of Mercury	Oxide of lead.
Bases of the muriatic and other undecomposed acids	Acids, gallic	Acids, gallic	Acids, gallic	Acids, sebacic	Acids, gallic
Carbon	muriatic	muriatic	muriatic	gallic	sulphuric
Phosphorus	nitric	sebacic	nitric	muriatic	sebacic
Hydrogen?	sulphuric	oxalic	sulphuric	oxalic	mucic
Sulphur	arsenic	sulphuric	arsenic	succinic	oxalic
Zinc	fluoric	mucous	fluoric	phosphoric	arsenic
Copper	tartarous	phosphoric	tartarous	sulphuric	tartarous
Lead	phosphoric	sulphurous	phosphoric	mucous	phosphoric
Iron	acetous	nitric	sebacic	tartarous	muriatic
Silver	sebacic	arsenic	oxalic	citric	sulphurous
Platina	prussic	fluoric	citric	malic	suberic
Mercury	Fixed alkalies	tartarous	acetous	sulphurous	nitric
Gold	Ammonia	citric	succinic	nitric	fluoric
Nitrous oxide	Sulphuretted hydrogen	succinic	prussic	fluoric	citric
Muriatic acid		acetous	carbonic	acetous	malic
Nitrous acid		prussic	Ammonia	benzoic	succinic
Sulphurous acid		carbonic		boracic	acetous
White oxide of manganese		Ammonia		prussic	benzoic
Volatile oils				carbonic	boracic
Alcohol				Ammonia	prussic
					carbonic
					Fixed alkalies
					Fat oils
					Ammonia

IN THE DRY WAY.

	Gold.	Silver.	Platina.	Mercury.	Lead.
Carbon	Mercury	Lead	Arsenic	Gold	Gold
Zinc	Copper	Copper	Gold	Silver	Silver
Iron	Silver	Mercury	Copper	Platina	Copper
Hydrogen	Lead	Bismuth	Tin	Lead	Mercury
Manganese	Bismuth	Tin	Bismuth	Tin	Bismuth
Cobalt	Tin	Gold	Zinc	Zinc	Tin
Nickel	Antimony	Antimony	Antimony	Bismuth	Antimony
Lead	Iron	Iron	Nickel	Copper	Platina
Tin	Platina	Manganese	Cobalt	Antimony	Arsenic
Phosphorous	Zinc	Zinc	Manganese	Arsenic	Zinc
Copper	Nickel	Arsenic	Iron	Iron	Nickel
Bismuth	Arsenic	Nickel	Lead	Alkaline sulphurets	Iron
Antimony	Cobalt	Platina	Silver	Sulphur	Alkaline sulphurets
Mercury at 600°	Manganese	Alkaline sulphurets	Mercury		Sulphur.
Arsenic	Alkaline sulphurets		Alkaline sulphurets		
Sugar					
Sulphur					
Gold					
Silver					
Platina					
Mercury at upwards of 1000°					
White oxide of manganese					

TABLE V. SIMPLE ELECTIVE ATTRACTIONS.

METALS (CONTINUED).

IN THE HUMID WAY.

Oxide of Copper.	Oxide of Iron.	Oxide of Tin.	Oxide of Bismuth.	Oxide of Nickel.	Oxide of Arsenic.
Acids, gallic	Acids, gallic	Acids, gallic	Acids, oxalic	Acids, oxalic	Acids, gallic
oxalic	oxalic	sebacic	arsenic	muriatic	muriatic
tartarous	tartarous	tartarous	tartarous	sulphuric	oxalic
muriatic	camphoric	muriatic	phosphoric	tartarous	sulphuric
sulphuric	sulphuric	sulphuric	sulphuric	nitric	nitric
mucous	mucous	oxalic	sebacic	sebacic	sebacic
nitric	muriatic	arsenic	muriatic	phosphoric	tartarous
sebacic	nitric	phosphoric	nitric	fluoric	phosphoric
arsenic	sebacic	nitric	fluoric	mucous	fluoric
phosphoric	phosphoric	succinic	mucous	succinic	mucous
succinic	arsenic	fluoric	succinic	citric	succinic
fluoric	fluoric	mucous	citric	acetous	citric
citric	succinic	citric	acetous	arsenic	arsenic
acetous	citric	acetous	prussic	boracic	acetous
boracic	acetous	boracic	carbonic	prussic	prussic
prussic	boracic	prussic	Ammonia	carbonic	Fixed alkalies
carbonic	prussic	Potash		Ammonia	Ammonia
Potash	carbonic	Soda			Fat oils
Soda		Ammonia			Water
Ammonia					
Compound salts					
Fat oils					

IN THE DRY WAY.

Copper.	Iron.	Tin.	Bismuth.	Nickel.	Arsenic.
Gold	Nickel	Zinc	Lead	Iron	Nickel
Silver	Cobalt	Mercury	Silver	Cobalt	Cobalt
Iron	Manganese	Copper	Gold	Arsenic	Copper
Arsenic	Arsenic	Antimony	Mercury	Copper	Iron
Manganese	Copper	Gold	Antimony	Gold	Silver
Zinc	Gold	Silver	Tin	Tin	Tin
Antimony	Silver	Lead	Copper	Antimony	Lead
Platina	Tin	Iron	Platina	Platina	Gold
Tin	Antimony	Manganese	Nickel	Bismuth	Platina
Lead	Platina	Nickel	Iron	Lead	Zinc
Nickel	Bismuth	Arsenic	Zinc	Silver	Antimony
Bismuth	Lead	Platina	Alkaline sulphurets	Zinc	Alkaline sulphurets
Cobalt	Alkaline sulphurets	Bismuth	Sulphur	Alkaline sulphurets	Sulphur
Mercury	Sulphur	Cobalt		Sulphur	
Alkaline sulphurets		Alkaline sulphurets			
Sulphur		Sulphur			

TABLE VI. SIMPLE ELECTIVE ATTRACTIONS.

METALS (CONCLUDED).

IN THE HUMID WAY.

Oxide of Cobalt.	Oxide of Zinc.	Oxide of Antimony.	Oxide of Manganese.	Oxide of Tellurium.	Oxide of Titanium.	Oxide of Uranium.
Acids, oxalic	Acids, gallic	Acids, gallic	Acids, oxalic	Acids, nitric	Acids, sulphuric	Acids, sulphuric
muriatic	oxalic	sebacic	tartarous	nitro-muriatic	nitric	nitro-muriatic
sulphuric	sulphuric	muriatic	citric	sulphuric	muriatic	muriatic
tartarous	muriatic	benzoic	fluoric	Sulphur	prussic	nitric
nitric	mucous	oxalic	phosphoric	Alkalies		phosphoric
sebacic	nitric	sulphuric	nitric	Mercury		acetous
phosphoric	sebacic	nitric	sulphuric			gallic
fluoric	tartarous	tartarous	muriatic			prussic
mucous	phosphoric	mucous	sebacic			carbonic
succinic	citric	phosphoric	arsenic			Sulphur
citric	succinic	citric	acetous			
acetous	fluoric	succinic	prussic			
arsenic	arsenic	fluoric	carbonic			
boracic	acetous	arsenic				
prussic	boracic	acetous				
carbonic	prussic	boracic				
Ammonia	carbonic	prussic				
	Fixed alkalies	carbonic				
	Ammonia	Sulphur				
		Fixed alkalies				
		Ammonia				

IN THE DRY WAY.

Cobalt.	Zinc.	Antimony.	Manganese.	Tellurium.
Iron	Copper	Iron	Copper	Mercury
Nickel	Antimony	Copper	Iron	Sulphur
Arsenic	Tin	Tin	Gold	
Copper	Mercury	Lead	Silver	
Gold	Silver	Nickel	Tin	
Platina	Gold	Silver	Alkaline sulphurets	
Tin	Cobalt	Bismuth		
Antimony	Arsenic	Zinc		
Zinc	Platina	Gold		
Alkaline sulphurets	Bismuth	Platina		
Sulphur	Lead	Mercury		
	Nickel	Arsenic		
	Iron	Cobalt		
		Alkaline sulphurets		
		Sulphur		

In the expression of compound affinities, the sketches must either be made from actual experiment in every instance, or by deduction from the numerical expressions of the forces of attraction. Some of the difficulties of effecting this have been mentioned in the present article; but as a conjectural set of numbers, inferred from such facts as we possess, may be useful in many instances to point out the probability of decompositions previously to trial, Guyton Morveau's table of the numerical expression of affinity between the alkalies and soluble earths, and the five principal acids, is here inserted.

TABLE VII. NUMERICAL EXPRESSION OF AFFINITIES.

BY GUYTON MORVEAU.

	Sulphuric acid.	Nitric acid.	Muriatic acid.	Acetic acid.	Carbonic acid.
Barytes	66	62	36	28	14
Potash........	62	58	32	26	9
Soda	58	50	31	25	8
Lime..........	54	44	23	19	12
Ammonia....	46	38	21	20	4
Magnesia.....	50	40	22	17	6
Alumine	40	36	18	15	2

The method of exhibiting simple or compound affinities by symbols, according to Bergman, consists in placing those substances which are applied to each other upon the same horizontal line of direction; the component parts of the substances being placed at the two extremities of a vertical bracket; and the new products, if any, are placed one above the other, at the middle part of a horizontal bracket, connecting their component principles. This will be rendered clearer by an example.

I. Suppose magnesia to be presented to a solution of sulphat of potash, it will be found that no decomposition takes place. These facts are expressed as follows:

$$\text{Sulphat of potash}\begin{cases}\text{Potash} & \\ & \\ \text{Sulphuric acid} & \text{Magnesia.}\end{cases}$$

In the above scheme, the sulphat of potash is placed opposite the point of a vertical bracket, and its two component parts, potash and sulphuric acid, are placed within the extremities of the same bracket. Horizontally opposite the sulphuric acid is placed magnesia, to denote, that it is presented to that acid. And as these two substances are not connected by a bracket, it is to be understood from the scheme, that they do not unite, and consequently that the sulphat of potash remains undecomposed.

II. On the contrary, if to a solution of sulphat of magnesia, potash be added, a decomposition will ensue, which is expressed as follows:

$$\text{Sulphat of magnesia}\begin{cases}\text{Magnesia} & \\ & \\ \underbrace{\text{Sulphuric acid} \quad\quad \text{Potash}}_{\text{Sulphat of potash}}\end{cases}$$

The arrangements in this scheme depend on the same principles as those of the foregoing: but the bracket underneath the sulphuric acid and potash denotes, that these two substances unite, and form sulphat of potash, which is accordingly placed beneath the middle of the bracket. The point of the bracket being turned up, is made to denote that the compound remains suspend-

ed, or in solution. The magnesia is of course disengaged: and half a bracket, with the point downward, is placed over it, to denote, that it falls to the bottom, or is precipitated.

III. The above instances exhibit simple elective attractions: but this method is more particularly applicable to the compound attractions. For example: Suppose a solution of the muriat of potash be added to sulphat of lime, no decomposition will take place. This is expressed as under:

Muriat of potash	Potash	Sulphuric acid	Sulphat of lime
	Muriatic acid	Lime	

The want of horizontal brackets in this scheme denotes, that the principles presented to each other do not unite, and, consequently, that no decomposition ensues.

IV. On the contrary, if sulphat of potash be presented to the muriat of lime, a mutual decomposition will ensue. Thus,

Muriat of potash

Sulphat of potash	Potash	Muriatic acid	Muriat of lime
	Sulphuric acid	Lime	

Sulphat of lime

In this scheme we see, that the principles presented to each other do unite, as is shown by the horizontal brackets, and form the new compounds, muriat of potash and sulphat of lime; the former of which remains in solution, as is shown by its bracket being turned upward; while the latter, being nearly insoluble, falls down, and is accordingly denoted by a bracket, the point of which is turned downward.

V. By attentively observing this last scheme, it may be seen, that the attractions exerted between the simple substances, which are placed over each other, are the quiescent affinities, and tend to preserve the original combinations; whereas the attractions between the simple substances which stand opposite to each other are the divellent affinities, and tend to produce new combinations. If we could determine numerically the simple attractions, it is evident, that we might foretel every result which might be produced by the application of compound substances to each other, under like substances; as may be shown by applying Morveau's numbers to the preceding scheme.

Muriat of potash

Sulphat of potash	Potash	32	Muriatic acid	Muriat of lime
	62	+	23=85	
	Sulphuric acid	54 — 86	Lime	

Sulphat of lime

The attraction between the potash and sulphuric acid is expressed by the number 62: and the attraction between the muriatic acid and lime is expressed by the number 23. These are the quiescent affinities, and their sum 85 expresses the tendency to preserve the original forms of sulphat of potash and muriat of lime. On the other hand, the attraction between the potash and muriatic acid is expressed by 32, and the attraction between sulphuric acid and lime by 54. The sum of 32 and 54 amounts to 86, and expresses the divellent affinities, which tend to produce new combinations. And as this last sum exceeds the sum of the quiescent affinities, it follows, that the double decomposition will take place.

VI. These examples have designedly been taken the reverse of each other; but every instance, singly exhibited, does in fact point out both the affirmative and the negative propositions. Thus, from the facts first exhibited, that magnesia does not decompose the combination of potash and sulphuric acid, it likewise follows, that potash does compose the combination of sulphuric acid and magnesia. And accordingly, in the last two schemes of double affinity, it is clearly ascertained, from the mutual decomposition of sulphat of potash and muriat of lime, that the muriat of potash and sulphat of lime will not decompose each other.

The same horizontal bracket, which in the humid way was used to denote solution, is used to denote sublimation in experiments in the dry way.

The following schemes from Bergman will require no explanation, after the instances we have exhibited.

SCHEMES OF ELECTIVE ATTRACTIONS IN THE HUMID WAY.

I.
Sulphat of potash
Potash
62
Sulphuric acid 66 Barytes
Sulphat of barytes

II.
Sulphat of potash
Potash
62
Sulphuric acid 54 Lime

III.
Muriat of soda
Soda
31
Muriatic acid 32 Potash
Muriat of potash

IV.
Muriat of lime
Lime
23
Muriatic acid 31 Soda
Muriat of soda

V.
Muriat of lime
Lime
23
Muriatic acid 21 Ammonia

VI.
Sulphat of potash
Sulphat of Magnesia
Sulphuric acid 62 Potash
50
Magnesia

VII.
Muriat of potash
Muriat of Mercury
Muriatic acid 32 Potash
Oxide of Mercury

VIII.
Sulphat of lime
Sulphat of iron
Sulphuric acid 54 Lime
Oxide of iron

IX.
Sulphat of potash with excess of acid
Sulphat of potash
Sulphuric acid
Potash ☞ Nitric acid
Nitre

X.
Sulphat of potash with excess of acid
Sulphat of potash
Sulphuric acid
Potash ☞ Tartarous acid

XI.
Muriat of potash
Muriatic acid
Potash ☞ Tartarous acid

XII.
Muriat of soda
Muriatic acid
31
Soda
Tartarous acid

Nitrat of soda
XIII.
Borat of soda
Soda 50 Nitric acid
Boracic acid

XIV.
Sulphat of lime
Sulphuric acid
54
Lime
Oxalic acid

XV.
Sulphat of Magnesia
Sulphuric acid
50
Magnesia
Fluoric acid

XVI.
Nitrat of lime
Nitric acid
44
Lime 54 Sulphuric acid
Sulphat of lime

XVII.
Arsenious acid
Muriatic acid
Oxygen
Oxygen
Arsenic
Oxy-genated muritic acid
Arsenic acid

Acetit of potash
XVIII.
Sulphuret of potash
Potash 26 Acetous acid
Sulphur

Sulphat of lime
XIX.
Sulphuret of lime
Lime 54 Sulphuric acid
Sulphur

Muriat of potash
XX.
Sulphat of pot-ash
Potash 32 Muriatic acid
62 + 23 = 85
Sulphu-ric acid 24/56 Lime
Muriat of lime
Sulphat of lime

Nitre
XXI.
Sulphat of pot-ash
Potash 58 Nitric acid
62
Sulphuric acid Oxide of lead
Nitrat of lead
Sulphat of lead

XXII.
Muriat of pot-ash
Potash 62 Sulphu-ric acid
32 + 54 = 86
Muriatic acid 23/85 Lime
Sulphat of lime

XXIII.

	Nitrat of ammonia		
Sulphat of ammonia	Ammonia 38	Nitric acid	Nitrat of mercury
	40		
	Sulphuric acid	Oxide of mercury	
	Sulphat of mercury		

XXIV.

	Nitrat of soda		
Common salt	Soda	Nitric acid	Nitrat of silver
	Muriatic acid	Silver	
	Muriat of silver		

XXV.

	Nitre		
Acidulous tartrit of potash.	Potash	Nitric acid	Nitrat of mercury.
	Tartarous acid	Oxide of mercury	
	Tartrit of mercury.		

XXVI.

	Nitrat of Soda		
Borax	Soda	Nitric acid	Nitrat of mercury
	Boracic acid	Oxide of mercury	
	Borat of mercury		

XXVII.

	Acetit of magnesia.		
Muriat of magnesia	Magnesia	Acetous acid	Acetit of silver
	Muriatic acid	Silver	
	Muriat of Silver		

XXVIII.

	Sulphat of lead		
Sulphat of silver	Sulphuric acid	Lead	Muriat of lead
	Silver	Muriatic acid	
	Muriat of silver.		

XXIX.

	Nitrat of copper.		
Nitrat of silver	Nitric acid	Copper	Muriat of copper
	Silver	Muriatic acid	
	Muriat of silver.		

XXX.

	Muriat of potash		
Common salt	Muriatic acid	Potash	Carbonat of potash
	Soda	Carbonic acid	
	Carbonat of Soda		

XXXI.

	Muriat of potash		
Muriat of mercury	Muriatic acid	Potash	Carbonat of potash
	Oxide of mercury	Carbonic acid	
	Carbonat of mercury.		

XXXII.

	Nitrat of Soda		
Nitrat of lead	Nitric acid	Soda	Carbonat of soda
	Oxide of lead	Carbonic acid	
	Carbonat of lead		

XXXIII.

Carbonat of magnesia

Sulphat of magnesia — Magnesia | Carbonic acid — Carbonat of soda

Sulphuric acid | Soda

Sulphat of soda

XXXIV.

Muriat of ammonia

Muriat of lime — Muriatic acid | Ammonia — Carbonat of ammonia

Lime | Carbonic acid

Carbonat of lime

XXXV.

Alcohol of potash — Alcohol | Ammonia — Carbonat of ammonia

Potash | Carbonic acid

Carbonat of potash

XXXVI.

Nitrat of copper

Nitrat of silver — Nitric acid, Oxygen — Copper

Silver

XXXVII.

Sulphat of iron

Sulphat of copper — Sulphuric acid, Oxygen — Iron

Copper

XXXVIII.

Sulphuret of potash or soda — Sulphur | Lead — Acetit of lead

Potash or soda | Acetous acid

Acetat of potash or soda

XXXIX.

Nitre

Solution of oxide of tungsten in potash — Potash | Nitric acid — Nitric acid

Potash, Oxide of tungsten — Nitric acid

Oxide of tungsten

SCHEMES OF ELECTIVE ATTRACTIONS IN THE DRY WAY.

1.
Sulphat of potash
Sulphuric acid
Potash
Phosphoric acid
Phosphat of potash

2.
Common salt
Muriatic acid
Soda
Nitric acid
Nitrat of soda

3.
Common salt.
Muriatic acid
Soda
Arsenic acid

4.
Ammonia
Muriatic acid
Ammonia
Sulphuric acid
Sulphat of ammonia

5.
Oxygenated muriatic acid
Muriatic acid
Oxygen
Manganese
Oxide of manganese.

6.
Muriat of ammonia
Ammonia
Muriatic acid
Lime
Muriat of lime

7.
Red sulphuret of mercury
Mercury
Sulphur
Iron

8.
Arseniat of potash or soda
Aeriform fluid
Oxygen
Carbon
Arsenic
Potash or soda

9.
Phosphat of ammonia
Azot
hydrog.
Ammonia
Phosphorus
Oxygen
Carbon
Carbonic acid
Car-bon

10.
Muriat of lime
Muriatic acid
Ammonia
Lime

11\.

Fluat of lime

Fluat of lime	Lime	
	Fluoric acid	Potash

12\.

Alloy of gold with silver.

Alloy of gold with silver.	Silver	Sulphur
	Gold	

13\.

Sulphuret of lead.	Sulphur	Iron
	Lead	

14\.

Combination of silver with sulphuret of alkali	Alkali Sulphur	Copper
	Silver	

15\.

Common salt.	Muriatic acid	Arsenic
	Soda	

16\.

Corrosive muriat of mercury	Mercury	
	Oxygen Muriatic acid	Antimony

Muriat of antimony

17\.

Sulphat of ammonia

Sulphat of potash	Sulphuric acid	Ammonia	Arseniat of ammonia
	Potash	Arsenic acid	

Arseniat of potash

18\.

Nitrat of ammonia

Nitre	Nitric acid	Ammonia	Sulphat of ammonia
	Potash	Sulphuric acid	

Sulphat of potash

19\.

Corrosive muriat of mercury

Common salt	Muriatic acid	Mercury Oxygen	Sulphat of mercury
	Soda	Sulphuric acid	

Sulphat of soda

20\.

Carbonat of ammonia

Muriat of ammonia	Ammonia	Carbonic acid	Carbonat of lime
	Muriatic acid	Lime	

Muriat of lime

21.

	Fluoric acid	Potash	
Fluat of lime			Carbonat of potash
	Lime	Carbonic acid	
	Chalk		

22.

	Copper	Sulphur	
Alloy of gold and copper			Sulphuret of antimony
	Gold	Antimony	

ELECTRICITY. The word electricity denotes a peculiar state, of which all bodies are susceptible, and which is supposed to depend upon the presence of a substance called the electric fluid. Some of its phenomena were known to the ancients, particularly those attractions and repulsions which a piece of amber, after being rubbed, exhibits, with regard to hairs, feathers, and other small bodies; and the name electricity is derived from the Greek word denoting amber.

This subject is so far from being well understood, even at present, that there is some difficulty even in classing the facts. They may, however, be stated as follows: A body in an electric state attracts other bodies, and these become electric by touching it, and are afterwards repelled. Bodies are capable of being electrified more or less strongly; and when the electric state is considerably strong, the electrified body will throw out luminous sparks, or flashes, to other bodies brought near it, and by that means communicate the same electric state to them, without actual contact.

The means by which bodies are rendered electric are so various, that it may be asserted, perhaps without exception, that every change, whether mechanical or chemical, which can take place in them, will at the same time produce electricity, or alter their electric state. When one body is applied to another, and they are afterwards separated; or if they be rubbed together; or if their parts be torn asunder; or if they be heated; or cooled; or evaporated; or congealed; or fused; or if any chemical combination be made to take place between them;—the signs of electricity become manifest, though with differences of intensity dependant on the nature of the bodies, as well as of the processes and the circumstances; some of which have been so far classed as to take the form of science, while others remain to be developed by new researches.

When the electric state is communicated from one body to another, very striking differences are observed in its effects. Some bodies become electrified only in those parts which are near the place of communication, and the electric state is considerably permanent; other bodies transmit the electric energy from part to part with great rapidity and facility. The former of these have been called non-conductors, and the latter conductors of electricity. From the properties here described, it will easily be understood, that a non-conductor cannot be made to exhibit the electric state for any perceptible portion of time, unless it be supported by a non-conductor. In this situation it is said to be insulated.

The state of electricity which is produced by chemical changes in bodies, has within a few late years greatly engaged the attention of the philosophical world, under the denomination of GALVANISM, which see.

It does not appear that the property of conducting electricity depends altogether on the nature or component parts of the conductors themselves, but rather on their state with regard to heat. Glass, resin, baked wood, atmospheric air, and many other bodies, which are non-conductors in the ordinary temperature of the atmosphere, become conductors when very hot; and on the contrary, ice cooled to 13° below 0 on Fahrenheit's scale, has all the properties of non-conductors. If we might generalize these facts, analogy would lead us to an induction, that, as the freezing points of bodies differ so greatly among each other, and in some, as in alcohol and the gases, it can only be admitted by supposition,—so there may be in all bodies some temperature pe-

culiar to each, below which its power of conducting electricity may be insensible.

Conductors of electricity, at the usual temperature of the atmosphere, are metals, charcoal, water, and very rare air; non-conductors are glass, gems, resins, amber, sulphur, silk, very dry wood, oils, dry air of the usual density, and the barometrical vacuum.

Electricity, or the cause of electric phenomena, is admitted by all philosophers to consist in some peculiar matter capable of being transmitted from place to place through conducting bodies. The most usual method of producing a strong electric state consists in rubbing a conducting body against a non-conductor, such, for example, as the hand, or a leather cushion, against a tube or cylinder of glass; for the conditions of which see EXCITATION. The surface of the glass thus becomes electrified, and will afford the electric state by communication to other bodies. An insulated metallic conductor, called the prime conductor, composes part of the machine used for this purpose. See MACHINE, *electric*.

When the rubber is insulated, it is found to acquire an electric state as well as the cylinder; but the states appear to be of different and opposite natures. For, though the cushion and bodies electrified by communication from it are observed to attract and repel small bodies, and to emit sparks to uninsulated conductors, in very nearly the same manner as is done by the cylinder, and such bodies as have been electrified by it; yet, with regard to each other they are so different, that communication between the two electricities puts an end to the effects of both; and bodies which, having been electrified by the cylinder, are in a state to be repelled by it, are so far from being affected in the same way by the cushion, that they are, on the contrary, attracted by it, and *vice versa*.

When sealing-wax is rubbed by the hand, it acquires upon its surface the opposite electricity to that which glass obtains by the same treatment; and hence the two electricities have been called the vitreous and resinous electricities by philosophers whose attention was directed principally to the non-conductor. But Dr. Franklin, who took notice of the state of the insulated rubber, adopted the hypothesis of one single electric fluid, and supposed it to be redundant, or positive, on the glass; and deficient, or negative, on the rubber.

In each hypothesis the matter of all bodies is supposed to attract the electric matter, and each single fluid to be repulsive of itself. In the hypothesis of two electric fluids, these are supposed to attract each other, and to become neutralized by union or combination. Each of these hypotheses will agree with most of the phenomena; and each presents its difficulties: but there are no decisive experiments which can entitle either to a preference. We shall use the terms positive and negative in this work, because most commonly adopted.

The kind of electricity produced by friction on the surface of the non-conductor depends, apparently, much less on the peculiar nature of the body, than on the mechanical structure of the surfaces. Thus the same rubber will produce the positive state on smooth glass, and the negative on rough, or unpolished glass; and sealing-wax will acquire the positive state, if rubbed by the amalgamed leather usually applied in our machines.

A body electrified in one state tends to produce the opposite state in another body, if brought near it so as not to communicate; and these opposite states diminish each other's apparent power or intensity, so as to admit of a much greater accumulation of electricity than could else have taken place. This may be better described by stating the fact along with one of the hypotheses. Suppose, for example, an insulated conductor to be positively electrified, or to contain more than the natural or ordinary quantity of electricity, this surplus will repel some of the natural quantity from another insulated conductor brought near it, and will drive that surplus out, if a communication be made with the earth; and in consequence of the negative state thus produced in this last, there will be an accumulation on the side of the first conductor nearest to the second, by virtue of the diminished repulsion of its electricity. The first conductor may, therefore, be made to receive still more; and this effect may be carried on until a spark or explosion shall take place through the non-conducting air. If glass be interposed, the spark will be rendered more difficult, and the accumulation, which is called the charge, may be made still greater. And if the conductors be removed, the charge may still remain at the surfaces of the glass; that is to say, the accumulation on the one surface, and the deficiency on the other, by a want of what

would else have naturally remained there. And if a circuitous conducting communication be made between the two sides, the charge will pass with an explosion. See Jar, *electric*, and Shock.

These are the principal facts of electricity. For the apparatus, instruments, manipulation, and other results, see Machine and Machinery, *electrical*.

ELECTROMETERS, certain instruments by which the intensity of an electric state is shewn. They operate either by means of the repulsion between two moveable bodies, or by measuring the distance to which the spark can be communicated. See Machinery, *electric*.

ELECTROPHORE, or Electrophorus, an instrument contrived by Sig. Volta for taking a small electric charge by induction, from a resinous plate, and afterwards transferring it as a simple spark. See Machinery, *electric*.

ELECTUARY. See Pharmacy.

ELEEMOSINARIUS, in law, the almoner, who received the eleemosinary rents and gifts, and duly distributed them to pious and charitable uses.

ELEGIA, in botany, a genus of the Dioecia Triandria class and order. Natural order of Calamariæ. Junci, Jussieu. There is but one species, *viz.* E. juncea.

ELEGIT, in law, is a writ of execution, either upon a judgment for debt or damages, or upon a forfeiture of the recognizance taken in the King's court, by which the plaintiff is put in possession of one half the debtor's lands, which he is possessed of at the time to hold them till his debt is paid out of the profits. By the common law, a man could only have satisfaction of goods, chattels, and the present profits of lands, by the writs of *fieri facias* or *levari facias;* but not the possession of the lands themselves. The statute 13 Edw. I. c. 18, therefore granted this writ, which is called an *elegit*, because it is in the election of the plaintiff, whether he will sue out this writ or one of the former.

ELEGY, a mournful and plaintive kind of poem. As elegy, at its first institution, was intended for tears, it expressed no other sentiments, it breathed no other accents but those of sorrow. With the negligence natural to affliction, it sought less to please than to move; and aimed at exciting pity, not admiration. By degrees, however, elegy degenerated from its original intention, and was employed upon all sorts of subjects, gay or sad, and especially upon love. Ovid's book of Love, the poems of Tibullus and Propertius, notwithstanding they are termed elegies, are sometimes so far from being sad, that they are scarcely serious. The chief subjects, then, to which elegy owes its rise, is death and love. That elegy, therefore, ought to be esteemed the most perfect in its kind which has somewhat of both at once; such, for instance, where the poet bewails the death of some youth or damsel falling a martyr to love.

ELEMENTS, a term used by the earlier chemists nearly in the same sense as the moderns use the term first principle. The chief and indeed very essential difference between them is, that the ancients considered their elements as bodies possessing absolute simplicity, and capable of forming all other bodies in their mutual combination; whereas the first principles of the moderns are considered as simple merely in respect to the present state of the art of analysing bodies: that is to say, the ancients almost totally overlooked the imperfections of the art in their general deductions; but the moderns pretend to keep it in view.

The experiments made in the infancy of chemistry had for their object the phenomenon of combustion, referred by them to a substance called fire; the extraction of elastic fluid, considered to be of the same nature as the immense mass which composes the atmosphere; water, neither compoundable nor destructible by any experiments then known or understood; and the substances not volatile in the strongest heat of furnaces, confounded by them, with a few exceptions, under the general term of earth. In this way they obtained four elements, or first principles, fire, air, water, and earth.

Subsequent experiments and enquiries have multiplied the nnmber of elements, and have alternately shewed the inutility of any exclusive general arrangement of bodies as absolutely simple, because not yet analysed. See Chemistry.

ELEMI, a resin, commonly called gum elemi, is supposed to be the produce of a large tree, called in the Linnæan arrangement amyris elemifera, a native of Carolina, and the warmer parts of America. The true elemi is supposed to come from Ethiopia. The resin is of a yellowish green; it comes to us in cylindrical cakes, covered with palm-leaves. When distilled in a

water bath, elemi affords about $\frac{1}{16}$ of essential oil, in which all the fragrance of the substance resides, the residue is inodorous and brittle. It is used in medicine as a liniment, and is employed in the arts as an ingredient in some varnishes.

ELEPHANT. See ELEPHAS.

ELEPHANTOPUS, in botany, *elephant's foot*, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Corymbiferæ, Jussieu. Essential character: calyx four-flowered; corolla tubular, hermaphrodite; receptacle naked; down bristle-form. There are four species.

The stems of these plants are woody; involucres three-leaved, containing three calyxes, sometimes large, boat-shaped, in very loose corymbs, and on long pedicles; frequently smaller in the shape of bractes and axillary, sessile and in spikes.

ELEPHAS, the *elephant*, in natural history, a genus of Mammalia of the order Bruta. Generic character: no fore-teeth in either jaw; tusks of the upper jaw elongated, none in the lower; proboscis very long and prehensile; body with few hairs. This animal is not to be met with in its natural state throughout Europe or America, and is to be found in its greatest perfection of size and strength between the river Senegal and the Cape of Good Hope in Africa. Its height is, generally, from twelve to fifteen feet. Its ears are so large, that from the shoulder of a middle-sized man they will extend to the ground. In a state of tranquillity these are pendulous, but during the agitation of passion they are erected, and pointed forwards with extreme intenseness. Its legs resemble massy pillars, above five feet in height, and sometimes sixteen inches in diameter. The most curious characteristic of the elephant is its proboscis, which is an instrument of feeling and of motion, and which it can contract or lengthen at pleasure, and apply with extreme flexibility and promptitude in every possible direction. With this most singular assistance, it grasps every object with both the feeling and tenacity of the human fingers. It thus picks up herbs and roots from the ground, unties the knots of cords, opens gates, and raises, without hesitation and difficulty, from the ground, the smallest coins. The nostrils are situated at the end of this instrument, which is the vehicle of its food and the weapon of its defence; and, in a full grown animal, is generally of the length of eight feet, and about five feet in diameter at the base. In the south of Africa, near the territory of the Cape, elephants are seen occasionally in herds even of several hundreds, and the settlers in the Cape territory are often engaged in the diversion, or rather, indeed, the profitable occupation of shooting them, in which practice has rendered them particularly skilful. It is an occupation, however, of no little adventure and peril, and the most perfect caution must be used to advance near enough to take the fatal aim unperceived, as, if the elephant observes his enemy, he will rush on him, not improbably, to his destruction. The weight of the tusks of a full grown elephant is about a hundred and fifty Dutch pounds, and they are sold for at least as many guilders; so that the temptation to this exercise is not only great to bold spirits, animated by the love of danger, but to mercenary ones, who can be stimulated to exertion merely by the love of gain.

The food of elephants consists of leaves, herbs, roots, the tender branches of trees, especially the plantain tree, and also of grains and fruits. A single one will eat in the course of twenty-four hours a hundred and fifty pounds of grass; and the quantity destroyed or spoilt by their trampling must be considered as far greater. As they act in concert both for forage and protection, they frequently break through the strong fences erected to keep them out, both by the Indians and the Negroes, laying waste, in one night, the most blooming pastures, overturning numerous habitations, blasting the hopes of harvest, defying the most hideous noises of the people to alarm them off, and disregarding the immense fires which are kindled for the same purpose. The usual motion of the elephant is not more rapid than the walk of a horse; but when urged by fear or anger his celerity is little inferior to a gallop, and he advances in a straight direction with this speed for a considerable time, without difficulty. In turning himself, however, he labours extremely, when confined within a small compass, and where it is practicable he always describes a circle of no small extent to accomplish it. In narrow and crooked passes the negroes avail themselves of this great disadvantage, and attack him with corresponding success.

Of all the animals applied by man to promote his ostentation or advantage, none

are possessed of more docility, sagacity, and obedience than the elephant. In the East they have been employed not only for labour, but for pomp, from the most remote periods of antiquity. They swim with great facility, and have been frequently of the most important service in transporting the baggage of armies over vast rivers. In swimming the trunk only appears above the surface of the water, effecting all the purposes of respiration. One of these animals will execute the work of several horses, and the promptitude, intelligence, and affection they display to their keeper, are singularly interesting. His voice is distinguished with unfailing accuracy; his tones of approval or anger, of command, attachment, or menace, are most nicely discriminated, and followed by corresponding acts and exertions. They will kneel down to facilitate his mounting on their backs, and assist him also in this operation with their trunk, with which they will likewise frequently smooth and caress him. They are employed in drawing large caravans, and even chariots, in the East, and appear pleased with the splendid and dazzling furniture in which they are often arrayed. They manifest extreme sensibility to honour and disgrace, and, to maintain the character of respectability, fidelity, and strength with their keeper, have been known, merely on his temporary ejaculation of disgust at the apparent relaxation of their efforts, to renew them with the most extraordinary animation, and even with the most fatal result.

Though formerly applied for the purposes of war, as was particularly the case against Alexander near the Hydaspes, and by Pyrrhus against the Romans, they were frequently more formidable to their owners than to the enemy, and, when wounded, exhibited a scene of extreme turbulence and confusion: and the invention of gunpowder appears to have precluded that advantage from their efforts in actual combat, which might, in some instances, in former ages, be occasionally derived from them. They are now chiefly employed in India for the purpose of state, or of labour, always forming an indispensible part of the magnificence attending a royal progress in the East. The vast quantities of baggage which are taken in those circuits are carried by some; while others, most splendidly arrayed, convey, in gilded and latticed houses, upon their backs, the ladies of the palace. It is stated that they are also employed sometimes in the execution of criminals, whether by trampling to death, fracturing the limbs of the unhappy convicts with their trunk, or impaling them on their tusks; following, for these purposes, the signals of their keepers, with complete precision and alertness.

The female produces but one young at a time, after a period of gestation consisting, according to some authorities, of two, and to others of three years. Elephants are thirty years before they attain their maturity, and are reported to live, even in a state of confinement, upwards of a century. In this state of captivity, however, they have proved, in every instance, barren; and this circumstance obliges eastern princes to supply the waste of accident, disease, and decay, by having annually recourse to the immense forests in which they abound. The hunting of them on these occasions is, indeed, an imperial sport, exciting very considerable interest, and attended with the most elaborate preparation. For the figure of the elephant, see Mammalia, Plate X. fig. 1.

ELEVATION, the same with altitude or height.

ELEVATION, *angle of*, in gunnery, that comprehended between the horizon and the line of direction of a cannon or mortar; or it is that which the chase of a piece, or the axis of its hollow cylinder, makes with the plane of the horizon.

ELEVATOR, in anatomy, the name of several muscles, so called from their serving to raise the parts of the body to which they belong.

ELEVATORY, in surgery, an instrument for raising depressed or fractured parts of the scull, to be applied after the integuments and periosteum are removed. If there is any hole, the instrument must be fastened to it; but if there is none, the screw-end of the instrument must be applied. See SURGERY.

ELISION, in grammar, the cutting off or suppressing a vowel at the end of a word, for the sake of sound or measure, the next word beginning with a vowel.

ELIXIR, in medicine, a compound tincture extracted from many efficacious ingredients; hence the difference between a tincture and an elixir seems to be this, that a tincture is drawn from one ingredient, sometimes with an addition of another to open it, and to dispose it to yield to the

menstruum; whereas an elixir is a tincture extracted from several ingredients at the same time. See TINCTURE.

ELK. See CERVUS.

ELL, a measure of length, different in different countries; but those mostly used in England are the English and Flemish ells, whereof the former is three feet nine inches, or one yard and a quarter, and the latter only twenty-seven inches, or three quarters of a yard. In Scotland, the ell contains $37\frac{2}{10}$ English inches.

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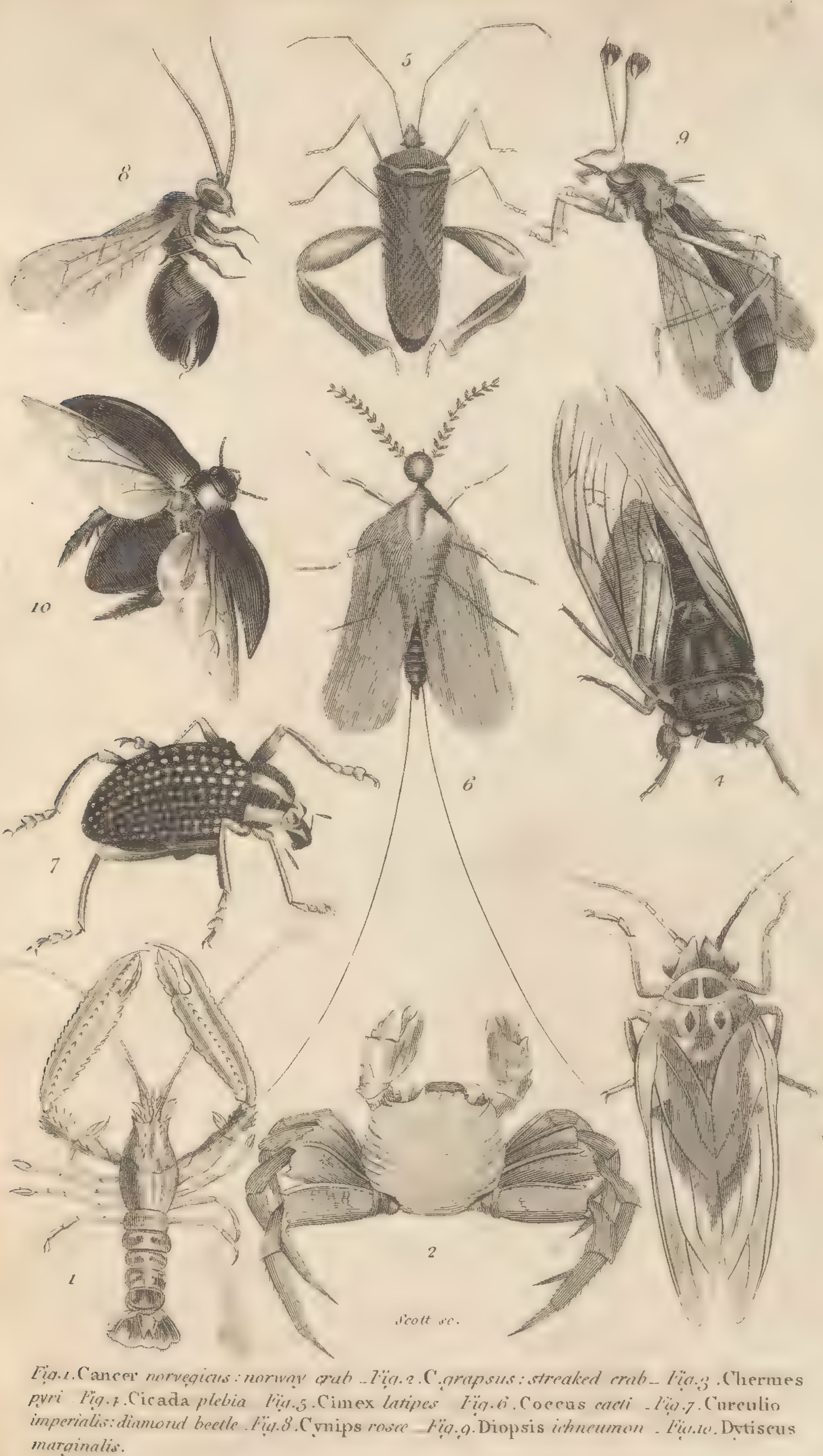

Fig.1. Cancer *norvegicus: norway crab* – *Fig.2.* C. *grapsus: streaked crab* – *Fig.3.* Chermes *pyri* *Fig.4.* Cicada *plebia* *Fig.5.* Cimex *latipes* *Fig.6.* Coccus *cacti* – *Fig.7.* Curculio *imperialis: diamond beetle* *Fig.8.* Cynips *rosœ* – *Fig.9.* Diopsis *ichneumon* – *Fig.10.* Dytiscus *marginalis.*

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